CHAPTER I

STRUCTURE AND RELIEF

The districts of Rudaun and Shahjahanpur form part of the Indo-Gangetic Plain which lies between northern Gondwana land of Peninsular India, in the south, and the recently built Himalayan chain of mountains, in the north. The plain is 400 kilometres broad at the most, and about 2400 kilometres long. But the Gangetic trough is only 1320 kilometres long.

The north Indian plain consists of the alluvium deposited through geologic ages by great Himalayan rivers. The nature of the detritus of various sizes from big boulders to silt and clay, the arrangement of the bedding, and the general form of the surface is due to sedimentation, laid down in gently inclined layers which are the principal types of river deposits. These extensive deposits of very young age are the stratified alluvial accumulations. The Gangetic trough, a synclinorials depression between peninsular India and the southern front of the Himalayas, is of post-Tertiary formation and filled up by Pleistocene alluviation.

The great Austrian geologist, Eduard Suess, holds that it is a 'fore-deep' formed in front of the resistant mass of the peninsula when the Tethyan sediments were thrust southward and compressed against them. He

thinks it is a foredeep fronting the Himalyan earthwaves, a "sagging" or subsidence of the northern part of the peninsula as it arrested the southward advance of the mountain waves.\(^1\) Burrard holds the view that the north Indian plains represent a rift-valley bounded by parallel faults on either side with a maximum downthrow of twenty miles.\(^2\) The Indian geologists have not accepted this view of the origin of Indo-Gangetic depression, because it has few geological facts in its support and does not confirm to geological/geo-physical observations.\(^3\) A third and more recent view regards this region as a sag in the crust formed between the northward drifting Indian continent and the comparatively soft sediments accumulated in the Tethyan basin when the latter were crumpled up and lifted up into a mountain system. The dynamical effect of either the first or the third view would appear to be the same. The depression perhaps began to form in the Upper Eocene and attained its greatest development during the third Himalayan upheaval in Middle Miocene. Since then it has gradually filled up by sediments to form a level plain with a very gentle seaward slope.\(^4\) Geological and geodetic data appear to support this view of the northward drift of the Indian continent and is more acceptable.\(^5\)

E.H. Pascoe and G.E. Pilgrim advocate that the Siwaliks were laid down in the flood plains of a single river, the Indobrahma or Sivalik river, which rose in Assam and followed the present line of distribution of these deposits. But Krishnan and N.K.N. Aiyangar discuss this question and show that the available evidence points to the basin of deposition being a continuous lagoon or fore-deep formed in front of the Himalayan range. It is almost certain that Siwaliks extend down for several miles underneath the alluvial cover of the Indus and Ganga Valleys. On the basis of characteristic Gondwana rocks found on the northern rims of the alluvial belt of the plain, Wadia and Auden maintain that the Archaean gneiss, the peninsular rocks, are continuous inside the plain. The continued loading of this belt by sedimentation since the first uplift of the Himalayan mountains may have accentuated the sinking of the archean floor, but as the process of sedimentation kept pace with that of depression, there arose the great plains of India. At the same time there was a gradual southward shift of the basin with each fresh pulse of the uplift.

The postulation of de Terra (1933-34) that the successive overlaps of younger over older beds from the Ganga Delta to the Northwest Panjab points to a great tilted syncline along which any master stream originally flowed to the southeast, has its own difficulties to be accepted.

2. ibid., p. 502.
The sunken basin or the depression in the crust, stretching from Sind to Assam, of considerable depth, is believed to have been created as a complimentary depression to the elevation of the Himalaya. There were gulfs stretching inland far to the north along the present valleys of the Indus and the Ganga, gulf of Sind and Assam. Its filling up by the sediments, silt, clay, sand, gravel, brought down from the newly upheaved Himalayas is most notable event of sub-recent times.\(^1\) The Indo-Gangetic alluvium contains ' a drift soil'.\(^2\)

Beneath the alluvium of the Gangetic Plains, Tertiary strata conceals what lies below it. However, structural events determined sedimentation, and, of course, no solid rock at any depth of drilling in the north Indian plain, and presence of ' only the sand washed down by Himalayan rivers through eons of geologic times from the summit of the Himalayas' reveal the geological part played by the Himalayan rivers in the formation of the North Indian plains.\(^5\)

The maximum depth of the alluvium is not ascertained.\(^1\) Some borings have been put down in the alluvial deposits to a depth of around 2000 feet for tapping water.\(^4\) The bore hole at Lucknow in Uttar Pradesh is only 1330 feet, which has not touched the rock-bottom.\(^5\) On the basis of geodetic

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data, Oldham finds the depth of the Gangetic trough to be 15,000 to 20,000 towards its northern edge.\(^1\) Cowie criticising the above findings postulated even higher figures from the same data.\(^2\) Recent calculations from geodetic surveys give a much lesser thickness for these lighter deposits resting on the dense Archaean bed-rock\(^3\), and thus Glennie challenged these figures on the basis of new gravity anomaly readings obtained from different stations in the plain and calculated the maximum depth of alluvium as 6500 feet. The figure calculated by Glennie confirms with geodetic data, though not with geological fact. It can not be regarded as reliable and may well be higher.\(^4\) The sub-montane Indo-Gangetic trough is believed to be 6,000-10,000 feet in depth.\(^5\)

All the borings that have hitherto been made, have failed to reach the rocky bottom.\(^6\) However, the deepest part is nearer the northern edge than the southern.\(^7\) It becomes gradually shallower towards the peninsular margin. Its floor has a fairly regular upward slope to the southern edge.\(^8\) The depth of the alluvium is at a maximum between Delhi and Rajmahal hills.\(^9\) Below the North Indian Tarai region, are the Nhabar plains of Upper Ganga Valley.

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The alluvial deposits of Budaun and Shahjahampur district of Uttar Pradesh are classified under two sub-divisions: old and new deposits, known as bangar and kender respectively. These deposits in respect of their geological age, correspond with the two main divisions of the Quaternary era: the Pleistocene and the Recent. Fossils characteristics of their age, which happen only rarely, may distinguish these deposits, otherwise, no demarcation can be drawn between them.

**BANGAR:**

The bangar land occupies the higher ground and is not flooded by the rivers during the rains. The prevailing material in the bangar alluvium is the nodular kanker, of carbonate of lime. The bangar encloses of the Pleistocene mammals Palaeoloxodon, Elephas, Equus, Rhinoceros, etc. The kanker, found in abundance, is the irregular concretion of impure calcareous matter. The older alluvium is distinguished by the nodular segregations of carbonate of lime or calcareous concretions which are abundant in the drier regions. The bangar land is characterised by patches of saline and alkaline efflorescences which are the result of the gentle slope of the land and the composition of the alluvium. The bangar, above the flood level generally, possesses clay and sodium clay as dominant constituent, reacting with kanker which liberates sodium carbonate and is turned into calcium clay.

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3. ibid., p. 160.
The banger as a rule occupies higher ground than the recent khadar.¹

Most of the kankar occurrence consists of irregular small pieces of varying diameters from one centimetre to ten centimetres or more, and according to Krishnan, it is of all shapes and sizes from small grains to big lumps.² Banger of the Ganga valley, rich in nodules of dark colour, bed fairly common feature in the older/ forms somewhat elevated mounds and terraces and is of Middle to Upper Pleistocene age.³ The vertical distribution of kankar or travertine beds is in well-defined layers varying from pure sand beds to those composed of heavy clays of impervious layers, continuous or intermittent, within the soil.⁴

The formation of kankar concretions is due to segregation of the calcareous material of the alluvial deposits into lumps or nodules somewhat like the formation of flint in limestone.⁵

According to Medlicot and Hlanford, the kankar nodules and the calcareous beds have been deposited from water containing a solution of carbonate of lime derived from the older rocks of various kinds or else from fragments of limestone contained in the alluvium.⁶

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In some places of upland bangar alluvium, the kankar concretions outcrop over wide areas at the surface, which in other places are found at a depth as great as thirty or forty feet. In the beds of Ganga masses of calcareous tufa are often found forming a matrix of conglomerates.

**KHADAR**

The newer alluvium of the Gangetic plain, called khadar, correspond with the Recent geologic age of the Quarternary era. The khadar, light coloured and often micaceous, sandy and poor in calcareous matter, prevails in general in the river valleys. The animal-remains in the khadar are mostly identical with living species.1 The khadar areas in the Gangetic plain are like 2 fingers along the main stream and their sub-parallel tributaries such as the Ramganga and Gomati.2 The khadar rivers annually refresh the area by their new silt, particularly in the main floodplains, which they bring from northern mountains. Nevertheless the khadar areas are of lower ground than that of bangar. The prevailing soil of khadar is sandy. It is almost pure sand on the banks of the Ganga, but as one proceeds away from the river, sandy character of the soil gradually decreases and is replaced by fine silt. This fine silt, called panga, is most fertile and is laid down by the river after the flood water has receded. But the area inundated by it is generally within two kms. from each of the

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1. Krishnan, M.S. *Introduction to Geology of India*, op.cit.,p. 170
banks. The khadar generally consists of sandy soil. The rivers have cut through bangar regions and formed their khadar areas at a lower level; the lower level is because of the principle that as the river gets older its deposits become progressively younger, and as the bed of the river continues to sink lower, the later deposits occupy a lower position along its basin than the earlier ones; khadar lands owe their origin to the bangar lands through the erosive action of the rivers; the remnants of bangar lands are subjected to erosion by the changes in the direction of the meandering river channels. The khadar contains lenticular beds of sand and gravel and peat beds, but it contains neither kankar nor reh salts. The lenses of sand and gravel, grading imperceptibly into recent alluvium, are good reservoirs of underground water.

Various names of khadar soils are there in different parts besides the fact that they are practically all sandy with sandy silt of varying consistency. The khapat, patka, bela and kamp are some of the local names of khadar soils. In some places which are marshy and lie at some distance from the khadar, heavy matiyar clays are found, which are quite suitable for cultivation. The layers of sub-soils of the khadar tract are generally uniform in texture, unlike those of bangar tracts which vary from pure sand to heavy clay in different layers. Khadar soils are comparatively less retentive of moisture than bangar soils; but as the sub-soil water level is

relatively high, these lands need no irrigation. The amount of nitrogen and organic matter in khadar soils is derived from the silts of the flood water and needs renewal every year for purposes of cultivation while in bangar soils they are comparatively more durable. The khadar is deficient in calcareous constituents but is entirely protected from injurious salts of soda and magnesia accumulations and from saline or alkaline efflorescences which reduce fertility and make the soil saline; while all these injurious matters may be present in bangar tracts. Unlike the khadar areas, saline and alkaline soils are found in areas of poor drainage with high evaporation. It is remarkable that the position of the khadar tract shifts with the shifting of river channel, and those khadar tracts which thus become inaccessible to river inundation are converted into bhur tract, as this area is deprived of annual deposition of fine silt, 'panga'. The bhur soil then cannot efficiently grow agricultural crops, and is only confined to typical crops of melons and water-melons. The continued productiveness of (khader) alluvial soils is moreover assured by the deposition, during overflows, of fresh soil-material brought down from the head waters of the stream. The khadar, consisting of a mixture of fine sand and silt, possesses usually very favourable physical composition. It has very fertile soil where there is sufficient plant food in the silt and sufficient moisture. Fresh khadar soils vary in accordance with local conditions. According to Glinka the principal regulator of the dynamic phenomena contributing to soil formation is the degree of

humidity prevailing in the soil. The interdependent factors of local
of orographic and hydrographical conditions are decisive importance for
the development, of khadar soil which are well worked easily. The
districts of Budaun and Shahjahanpur have a considerable area of low
lying khadar, a tract of very diverse appearance and fertility. In
Budaun district, the high cliffs form the eastern boundary of the khadar;
below these cliffs lies a broad shallow depression which represents the
old river bed. While in Shahjahanpur district the khadar is also known as
tarai or lowland. The low valleys of Shahjahanpur khadar have been
formed by a long process of erosion and deposition, the force of the
current and the consistency of the soil have determined its width.

Most of the area of Budaun district has bangar land except the khadar
strips of the Ganga and Ramganga in the west, south and east of the
district. The bangar land of Budaun District continues to southeast upto
the juncture of khadar strips of the Ganga and Ramganga in the southwest
of the district Shahjahanpur. In this district the bangar tract embraces
the greater portion than khadar, although the former contains many internal
tracts or facets. The plain is of very fertile loamy soil, varying in
depression by clayey loam, and by light sandy soils on the river banks and
higher levels. The bangar is present here and there in large tracts in
most parts, particularly in Shahjahanpur district; the continuation of
bangar tracts is interrupted by khadar strips or sandy banks of the rivers.

p. 148.
DRAINAGE

The districts of Budaun and Shahjahanpur generally form part of the alluvial plain of the Ganga which has a gentle slope from north-northwest to south-southeast and is drained well by the Ganga and its tributaries which join the river on its left bank. The surface drainage of the area constitutes a well-marked slope from northwest to southeast in the district of Budaun, while the slope is generally from north to south in the district of Shahjahanpur. The fertility of the land is directly related to the overflow of the rivers which come from Himalaya mountains. The Ganga and its tributaries which come from the Himalayas are perennial. The seasonal tributaries, however, are less important in enriching the soil as compared with perennial rivers.

The Ganga, Sot, Ramganga, Deoha and the Gomati are the main channels of drainage of the area along with their numerous seasonal tributaries. The different soil tracts are apparently distinguished by the character of drainage channels; khadar is related to the Ganga or Ramganga or Gomati rivers, while the bhur tract is practically devoid of any drainage and suffers occasionally from drought. The greatest of all is the river Ganga which produces no meander at all throughout its length of 149 kilometres in Budaun district in the west and south. The second largest river
of the area which forms the biggest tributary of the Ganga is the Ramganga
which has a meander just in the middle of the area. It is remarkable that
the lesser tributaries namely Sot, Aril, Deoha, and Bahgul produce fine
meanders in the area.

The course and character of the natural drainage channels mainly
determine the general topography and the surface, the slope of which is
evident from their courses. The district of Shahjahanpur is divided broadly
into valleys of numerous streams and channels, and is gently sloping
towards the south,. The rivers at places have formed ox-bow lakes. Ganga,
Ramganga, Sot, Mahawa, Bahgul, Khanaut, Deoha and Gomati are perennial
rivers. The Ganga khadar is generally flooded in the rainy months. The
drainage of the eastern portion of Budaun is believed to have been a channel
has
known as the kadvara , which has been silted up. The Aril river /given rise
to some lakes. In the rainy season, when the river is in spate, it has a
devastating effect.

The Ganga: It is the biggest river of the area and forms 149 kilometres
long boundary in the west and south of the Budaun district. The total area
of Budaun district is constantly liable to variations owing to the changes
in the course of the river.

The level of the land, where the Ganga enters the area near village
Dippur in the Rajpura pargana, is 184 metres above the sea level. Along its
course from northwest to southeast, it passes through a marked gradient of
0.22 metre per kilometre. The height of the land it passes through is 158
metres at Qadir Chouk and 151 metres in the extreme southeast corner of
Budaun district.
The Tributaries of Ganga:

- The upper courses of Ramganga, Gomati and Deoha have meandering and more steep gradients than their lower courses. After every flood these rivers may change their courses sideways maintaining the meanders; but owing to the general slope of the area their courses never become straight and no ox-bow lake is to be seen adjacent to their upper courses. Some of the numerous streams originate in the area, some a few miles north of the area; some of them maintain their definite courses for the most part of the year, while some change their courses, more or less, owing to backwaters of their channels.

The Mahawa: It is the third largest tributary of the Ganga in the area both in length as well as breadth. The course of the Mahawa for the most part is parallel to the Ganga. The Mahawa originates about 3 kilometres to the north of Bachhraon town of Moradabad district in the northwest of the area. After it enters into Budaun district 2 kilometres northwest of Gawan, its breadth and volume increase gradually. It receives waters of numerous seasonal small streams which generally flow from north-west to southeast. Flowing in the same direction it enters Budaun district, on a land of 186 metres above sea level near village Mariaoli, where it is nearest to the Ganga and passes through the Ganga-khadar, and where east of the Mahawa course there are many villages named with the suffix 'khadar'. And just alongwith its entry into the area it meanders. It forms a big meander at a distance of 2.4 kilometres after its entry into the area. It is also called as western Bagad Nadi here. It flows near Rajpura at 179 metres above sea
level while near Sahaswan it flows at 166 metres. Ultimately it joins Ganga nearabout the middle of the length of Budaun district 2.4 kilometres west of Kachhla, a famous religious centre of annual gathering for sacred bathing in Ganga. The land along Mahawa throughout has numerous long lakes. Throughout its course in the area it forms meandering course and forms numerous ox-bow lakes, such as in the west of Govan, southeast of Rajpura, and further east. In the rainy season when it is flooded, it flows in two distinct channels, one of which is seasonal. The seasonal course is at a distance of about 5.6 kilometres from the main perennial course in the west. This seasonal course is also punctuated by some meanders. But as the rainy season ends, this seasonal course dries up and the deeper parts of it are converted into lakes.

Its upper and the lower parts of the course in the area are in the main khadar tract while the rest of its course is in the Bangerland. In the northwest of Sahaswan and at a distance of 5 kilometres from the Mahawa, there is a big semi-circular lake named Dhand, in addition to many small lakes. In the rainy season these lakes join and form continuous sheet of water and the water overflows in the Mahawa.

Tikta: It is also called as Eastern Bagad Nadi. Rising in the district of Moradabad it enters the area from northwest and adopting a southeasterly course it forms the district boundary of Budaun for 2.5 kilometres and then adopts an easterly course and after flowing for some distance it receives the water of a long narrow lake and that of Purainia jhil
near the district boundary of Moradabad. It receives the water of the
Andheria and other small seasonal channels. The lake forms the district
boundary of Budaun for 6 kilometres. After it, the river joins the Mahawa
on its eastern bank.

The Burdmar: With the name of Singli nadi it originates 4.8 kilometres
northwest of Rajpura village, and 13 kilometres after its original point
it becomes a strong seasonal stream and is re-named as Burdmar nadi.
Flowing eastward, it finally joins Mahawa at the latter's right bank.
The height of the land where it meets Mahawa is 176 metres above sea
level. This is the only big tributary of Mahawa on its right bank in
the area. It roughly flows in a parallel course to Mahawa, except in
the last part.

The Chhoiya: It originates with a broken and undefined course in the
Sambhal Tahsil of Moradabad district; but when it enters the area
north 1.5 kilometres of village Manikpur, it attains a definite course which
is from northwest to southeast. It is completely a seasonal stream. The
land through which it flows is comparatively low-lying with some occa­sional marshes and lakes. Owing to its low lying area the tract is subject
to serious waterlogging in the season of rains. This tract was formerly
occupied by numerous small seasonal channels known as Kadyaras which
discharged their water in the Mahawa. The channels have now been silted
up and the area is now occupied by marshy lands. The Chhoiya river is
the only remnant. In the absence of adequate drainage the area is imun­dated during heavy rains.
The Bhainsaur: It originates from a seasonal lake and flows in a southeasterly direction. It is a seasonal channel.

Upto Bilsai and Sirasaul its course is broken, mostly liable to be changed and undefined, but after it, its course is well-defined and then its course begins to be very meandering until it joins Sota nadi. It receives the water of a seasonal channel Kamra Nadi which originates from 3 long lakes and in a meandering way it meets the Bhainsaur to the northeast of village Bhainsora. It will be seen that the village Bhainsora situated on the river Bhainsaur has been named after it. The Kamra nadi is parallel to firstly Mahawa and afterwards to Ganga. After receiving the Kamra, the Bhainsaur crosses only 2 kilometres of land when it has to fall into the Sota Nadi. The Bhainsaur flows in Bangar tract except in its lower course.

The Sota: It takes its water firstly from the Bhainsaur and then flows southeastward and finally joins Ganga. It assumes enormous volume in the rainy seasons, and flows in a meandering course. In the rainy season it receives a water-channel coming from the Ganga to meet the Sota. In the rainy season it receives many seasonal channels on its both sides which come from semi-circular and very long but narrow lakes, particularly on its left side. Four semi-circular lakes on its left side are noteworthy around Qadir Chouk and Kakora. It is just possible that the upper parts of these lakes would have been the former course of the Sota Nadi. As a result every lake has a tendency to flow to the present course of Sota. The presence of a number of ox-bow lakes close to the left bank of the river clearly indicates that the river was flowing at a distance of about two or three kilometres away from its present course.
The Sot or Yar-i-Wafadar: This is a perennial river. It has the longest course in Banger land where it is also called as Yar-i-Wafadar, meaning to be the 'faithful friend'. It originates at 3.2 kilometres west of Amroha in Moradabad district. Flowing from west to east and then to southeast, it forms 3.2 kilometres long boundary of the district Budaun in the northwest. It passes through the heart of the Budaun district covering the whole district from northwest to southeast. Throughout its course in the area it forms numerous meanders and receives numerous seasonal channels on its both sides. So many ferries are found in its course but most of them are not fordable during the rainy season. It enters the area 2 kilometres southwest of village Kheradas at a height of 183 metres above sea level. During its length of 118 kilometres in the area it has a gradient of one third of a meter per kilometre. It forms the boundaries of Sahaswan, Bisauli and Budaun tahsils. On its right bank, it receives a small stream Chhoiya nadi.

The southwest part of the Budaun city, named Sota, has a great slope in the southwest with an angle of about 45° and a depth of 7.5 metres. The lower land is the abandoned course of the Sot river, stretching from west of the city to the south throughout. The river has now gone 540 metres away from its old course. The soil of the old course is now cultivated and is very fertile loam in which the crops of tobacco, wheat and vegetables are well-grown. In the Dataganj Tahsil it receives the water of Bheti nala which flows in 3 channels from a lake of 5.6 kilometres length.
The river enters the Shahjahanpur district where it receives numerous small seasonal streams on both sides, particularly the left side. It receives also a large seasonal stream, Kadwara, which originates and flows in the lowland of Dataganj Tahsil through numerous long lakes. Flowing in a meandering course it meets the Sot on the latter's left bank. The Kadwara receives two small seasonal streams, Aril Nadi and Sotia Nadi, the latter comes from the Ramganga. Finally it flows south of the area to meet with the Ganga. The Sot is completely of bangar land except its lower reaches, where it goes through the khadar land of the Ganga. There are fine opportunities to build canals out of the Sot river in the northwest of the area to irrigate the best loamy soil tract.

**The Ramganga:** The greatest tributary of the Ganga in the area is the Ramganga. It has a course from north to south till it touches the inter-district boundary of Budaun and Shahjahanpur, after which it adopts the southeastern course. It is neither parallel nor perpendicular to the Ganga. Coming into the area from Bareilly district in a wide meandering course, 2.5 kilometres northeast of village Sahora, it covers a broad course, particularly in the rainy season. Though it is a perennial stream coming out from Himalaya, and has a well-defined course, yet the area under its course is liable to continual change owing to shifting of river bed. The khadar area of the Ramganga, the width of which depends on both the volume and force of the current and the consistency of the soil particularly in floods, is a low lying tract. But, as a matter of fact, the surface of the land is subject to annual inundation depositing fine sand and silt, and
is same and similar in character to that of the Ganga. The underground water-table is high. The soil consists of sandy alluvial silt and is easily well-worked as the water itself exercises a far-reaching influence on the process of soil formation and on the changes which take place in the soil.

When the Ramganga overflows its banks, it destroys many standing crops nearby, if the flood occurs in the middle or the last of the kharif season, its turbid water spreads in a thin sheet over the level ground bordering the river and deposits fine silt which usually gives rise to a soil of great richness. The flood occasionally becomes destructive to village settlements. Hence the most valuable richness of the soil is at the risk of occasionally possible destruction.

The level of the land where it enters the area is 159 metres high above sea level. The gradient of the land it traverses is 0. 28 metre per kilometre from north-northwest to southeast in the area.

For most of the people, the Ramganga is the second holiest river, next to Ganga, for washing off their sins by taking bath in it religiously. Hence annual fairs of bathing are held at certain places. The river in the rainy season is not fordable and many ferries are established at the places of its shortest possible width.

The Budaun's eastern low-land consisting of numerous lakes, small and large water-channels, marshes, other land-depressions and waterlogged patches of land, mostly represents an ancient bed of the river Ramganga and is now locally known as 'bankati' in the Budaun district.1

In a width of 50 to 100 metres from each of the river banks, the deposited sand is coarse and fine and is found in the hot weather season when the crops of melons, water-melons, cucumbers and vegetables are grown. After this sandy strip, the actual khader land stretches, which is liable to move in due course of time along with the shift of the river channel.

So many streams, small or large, drift into the Ramganga on both of its banks, such as the Narha, the Aril, the Bahgul, etc. But remarkably most of them join Ramganga on its left side, actually following the character of the Ganga. A very fine ox-bow lake is situated at about 3 kilometres south-west of Jalalabad town (Shahjahanpur).

The Tributaries of Ramganga:

The Aril: It originates in Maithani village of Tahsil Bilari in Moradabad district. Numerous meanders are seen throughout its course in the area. It is a large tributary of Ramganga. Being a perennial river, it becomes a forceful stream in the rainy season. It has a well-defined course and a deep bed. The banks at places are broken by ravines. During the rainy season it attains large size and spreads in the adjoining low lands. It is not fordable this season. In its upper part of the area, it drains the gently sloping land consisting of loamy soil, but in its lower part of the area, it produces waterlogging.

Coming into the area 5 kilometres northeast of village Sisarka it forms the boundary of about 1.3 kilometres between Moradabad and Budaun districts. It again forms 13 kilometres long boundary of Rampur and Bareilly districts with Budaun, after that it leaves the area entering into Bareilly district where it is called as Fairiya nadi. It again enters the area 4 kilometres northwest of village Faridpur after forming a boundary of 4 kilometres between Bareilly and Budaun districts. It then flows southeastward entering the low land of Budaun district. The Bajha nadi from northwest and Andheria nadi from north meet the Aril. The courses of the Bajha and the Aril in this region are devious and meandering.

There are numerous long and curved lakes in the lowland, some of them are ox-bow lakes. Then it falls into the Ramganga on its right bank, 1 kilometre northeast of village Chitri.

**The Kadwara:** The bad-land topography of the lowland on its western side has many seasonal channels, like the Kadwara Nadi, yet the worst drainage produces most adverse effects of waterlogging. The Kadwara originates in the upper part of this lowland. The outflows of some seasonal lakes in the northern part of the lowland re-shape into a stream which draws waters of many large lakes.

It is the seasonal stream of marshy land full of numerous long and curved lakes, which all tend to promote waterlogging.
The Narha: The upper course of it originating from a seasonal ox-bow lake of Ramganga, 2 kilometres east of Ballia, Tahsil Aonla (Bareilly), is totally seasonal. Growing gradually, it receives numerous small seasonal channels on its both sides. Flowing to south, it comes nearer to Ramganga. The southern half of the course generally contains water for the most of the year; its course here is well-defined. Its breadth increases considerably in the last, before it falls into Ramganga on its right bank. However, it is a small stream, but is quite long.

The Bahgul: This perennial river originates in the Tarai of Nainital district and crossing the district of Bareilly, it enters into the area 4 kilometres northwest of Jalalpur village where it forms the inter-district boundary of Bareilly and Shahjahanpur for 12.5 kilometres north to south. The Bahgul is full of meanders nearly throughout its course, which is well-defined. The area it traverses is liable to be inundated in the rainy season. It receives many seasonal streams like the Andhloi which joins it on the right side. The Bahgul is known as East Bahgul in its upper part in the area. It has numerous ox-bow lakes in its lower reaches in the area on eastern side. A seasonal tributary originating 3 kilometres southwest of Tilhar town, meets Bahgul on its left side. The tributary becomes a huge stream in the rainy season; its initial course for 16 kilometres remains broken and undefined for many months, but the rest 21.6 kilometres long course is well-marked. During the rainy season, the whole stream becomes full of water.
The Bahgul finally falls into the Ramganga on its left bank. It also plays an important role of the irrigation in the adjoining area for most of the year.

**The Garra and the Tributaries:**

**The Garra or Deoha:** This perennial river comes from Tarai region of Nainital and, crossing the district of Pilibhit in a north to south direction, it enters the area 3 kilometres north of village Majkhkhera. It flows through a meandering and curved course. It receives so many seasonal and perennial rivers on its both sides, of which the Khanaut on the left bank of Garra is a perennial river. Originating from a lake near village Falia Darobast, 6 kilometres south of Khudaganj, the Baksi nadi flows seasonally being roughly parallel to Garra, and meeting with another seasonal channel named Garai nadi, 4.8 kilometres east of town Kant, it attains a well-defined course which is commonly known in its southern half as the Gurrai nadi which receives waters of numerous small seasonal channels on both sides. Finally it joins the Garra (Deoha) on its right bank. The Katna nadi, a seasonal stream forming the inter-district boundary of Pilibhit and Shahjahanpur for 11 kilometres, flows then southward in a meandering form and falls into the Garra on its left side.

The Garra forms its own khadar strip, which is lesser in width than that of Ramganga. Another tributary of the Garra meeting on its left bank is Kaimua nadi, a seasonal stream which originates from a lake. It also gets the Khandni nadi on its left, which makes inter-district boundary also.
The Khanaut: The Khanaut is the large tributary of the Garra and is perennial throughout. It comes into the area from Pilibhit at 2 kilometres northwest of village Baribara and forms the district boundary for about 32 kilometres in the north of the area. Then flowing south it receives many seasonal streams on its both sides like the Sakaria nadi, Barah nadi, and others. Passing through the east of the Shahjahanpur city, it ultimately joins the Garra on its left side some 3.5 kilometres south of the city at Daniapur village. The areas near the mentioned streams have many permanent big and small lakes, particularly in the east of the Khanaut and the Garra. At the juncture of the Khanaut and Garra in the north of Daniapur village, the Garra forms very high vertical bank like cliff and has a low but wide bed, while the Khanaut does not have such a high banks anywhere and possesses very low, sloping and broad banks.

The Sukheta: Originating from a large lake, it passes through two other big lakes and flows southward. It forms the inter-district boundary of Shahjahanpur and Hardoi for about 21 kilometres from north to south. It is a seasonal stream but has a defined course.

The Gomati and the Tributaries:

The Gomati: The name of the river corresponds to the local word "ghoomti", meaning as curving purporting to be meandering. This characteristic feature of it is found throughout its course with some distances. It originates near village Sabalpur, Tahsil Puranpur, district Pilibhit at 7 kilometres north of our area. It is not a large river in the
area. It is fordable at 21 places for most of the year, except in the rainy season. Receiving the Joknai, it becomes a big river. A small stream, Barua nadi, meets Joknai. These streams possess defined courses, while banks of the Gomati are at places high and permanent. Nevertheless, its volume and effect increase in the rainy season largely. Only 2 ferries work in the rainy season. The velocity of the flowing water is great. The upper quarter of the course has high banks, while the banks of the rest course tend to be gradually lower. It is why the flood water spread much over the adjacent land of the last half course of the area. The left bank of Gomati is lower than the right bank. Both the banks of Upper Joknai are depressed while the left bank in the central and southern reaches is high. It is noteworthy that the area in between the Gomati and Joknai is mostly waste land, full of wild bushes, wild grass and some wild trees, except a few acres of land under cultivation. The khadar area on the right bank of Gomati and the land left of Joknai are liable to annual inundation during rainy season. It is important that the Gomati's khadar tract on its right side is safely cultivated in the most part of the year and there is no danger of erosion of land or deposition of coarse or infertile sand. The cultivation to its right bank shows that the river when in flood, brings fine and fertile silt and deposits it here; the far off situation of village-settlements confirm this fact. Not a single settlement is there on the left of Joknai within a distance of 2.8 kilometres from the stream which indicates devastating influence of Joknai in the rainy season in the upper part of it, while the last two third of the Joknai permits cultivation on its left upto its confluence. But a few patches of waste land in the agricultural area are also found. The Joknai forms a
permanent lake also adjacent to its channel which is 4 kilometres above its confluence with the Gomati. The Gomati receives another seasonal stream, the Bhainsi, on its right bank. In its upper part the Bhainsi has a seasonal channel of 6 kilometres after which it generally contains water for a big part of the year. It has a wide course thereafter. It also overflows in the rainy season draining the large area. In its last reaches before joining the Gomati, it has adverse effects on land producing waste land mostly on the left side. At last the Gomati flows southeastward forming the boundary of the area for about 1.6 kilometres. The Gomati's course throughout is meandering, mostly in the later part of the area. The Gomati leaves the area 4 kilometres northeast of the village Ageona Buzurg.

The Kathna; originating in the area from a small lake north of village Bansupur of Pawayan Tahsil, commands a seasonal channel up to a long lake situated on the inter-district boundary of Shahjahanpur and Lakhimpur, after which it attains a large course flowing to the south where this river has got a well-defined course and forms the inter-district boundary above mentioned for about 17.6 kilometres from north to south. At first it flows in the rainy season through cultivated land of best fertile loam, but its large course forming the district boundary, has Gadnia Reserved Forest on its left while cultivated land on its right. The last reaches of the river have to flow through the belt of forest, where the agricultural activity is at minimum. The course of the river in the area is curved but not meandering.
The Ul: Forming the easternmost boundary of the area, the Ul river flows in a broad course from NW to SE. It originates in the Reserved Forest some 4 kilometres NW before touching the area's eastern boundary. Throughout it flows through the Reserved Forest except only a few acres of cultivated land on the boundary. At the close of rainy season, it becomes a dry broad strip of sandy waste; and its remaining water is generally known to be injurious to cattle and produces fever if a man would drink.
PHYSICAL DIVISIONS

On the basis of relief and surface drainage the area may be divided into the following physical divisions (Fig. 5):

I. The Khadar

II. (a) Ganga-Sot interfluve
    (b) Bahgul-Deoha interfluve

III. Bhur tract

IV. (a) Sot-Aril, Kadwara interfluve
    (b) Deoha-Gomati interfluve
    (c) Trans-Gomati Plain

V. Aril, Kadwara- Ramganga and Ramganga- Bahgul interfluve

I. The Khadar

The width of the khadar lands varies along the rivers Ganga, Ramganga, Deoha and Gomati. The characteristic feature of the area is the abundance of moisture in the soil, which is due to nearness of the sub-soil water. During the rains, some of its parts either turn into swamps or are submerged under water; while in the winter season the soil remains almost saturated with moisture. The aggradational work of the river plays an important role in altering the nature of land. The deposition of coarse sand renders the land infertile while deposition of fine-fertile silt called 'panga' is very useful for agriculture.

II. (a) Ganga-Sot Interfluve

The area, having many small seasonal rivers and streams, has a large wasteland area in the west owing to erosive action of the streams. The sub-soil water-table remains very low, and the water level in the
Mahawa and Sot rivers reduces considerably. Usar land, jungles and meadows are found in patches alongwith the cultivated land. The soil is chiefly sandy loam. The slope of the land is from northwest to southeast.

(b) Bahgul-Deoha Interfluve

In the east of the Bahgul and Ramganga, the area is not liable to floods. The gentle slope of the land is from north to south. The sub-soil water-table is low which varies from five to seven metres. The area is well-drained by some small seasonal channels. There are also a few ephemeral lakes in this region.

III. Bhur Tract

Lying in the western part of the area, the bhur tract has mostly dry sandy soil. The characteristic features of the tract are vast usar and sandy patches of land. The area is almost devoid of rivers and lakes, and where they are found, they are a good source of irrigation. The tract is sub-divided into three types of land: (i) thandi bhur — the cultivable land, (ii) the lokharia bhur — characterized by high sandy ridges, and (iii) the urani bhur — the land occupied by wind-blown sand. The sub-soil water table is very low, being usually 7 to 10 metres.

IV. (a) Sot-Aril, Kadwara Interfluve

Being characterized by the well-drained plain, the tract occupies good loamy soil. A number of seasonal lakes and small seasonal streams are also found. Most of the area is cultivated and the waste lands are small. The eastern part tapers away to a narrow belt on account of the extension of the Ganga khadar in the south and the low-land area in the north. The sub-soil water-table is generally from 6 to 8 metres.
(b) Deoha-Gomati Interfluve

The tract consists of loamy soil and is well-drained. There are numerous seasonal and perennial lakes and streams. In the northeast of the tract, the land has numerous patches of waste land in between large areas of cultivated land. The underground water-table is generally 6 to 8 metres. Most of the canals are situated in this tract.

(c) Trans-Gomati Plain

Occupying a loamy soil tract, the area in the east and northeast is mostly under meadows and woodland. The tract is mostly tarai land, possessing a high water-table and remains generally saturated with moisture. There are numerous lakes and swamps in the tract. Wild trees and grass are also found. Most of the western part of this tract is under cultivation, while most of the eastern part is under meadows and woodlands. The seasonal river Ul which forms the northeastern boundary of Shahjahanpur district is locally known as containing poisonous water for both cattle and human being.

V. Aril, Kadwara-Ramganga and Ramganga-Bhagul Interfluve

The tract occupies a low-land area which is mostly subjected to water-logging particularly in the west of Ramganga river. The tract is occupied by a continuation of numerous lakes and streams. Many of the lakes are large and permanent. During the season of rains, the lakes expand considerably and they are usually connected with each other due to overflow. The bad-drainage conditions are a serious set-back for the cultivators.
The soil of the tract is generally clayey loam. The water-logging in the rainy season becomes so serious that means of communications are practically disrupted between the villages. The underground water-table remains generally high, varying from one to three or four metres. The presence of ox-bow lakes to the west of the river Ramganga indicates the former course of the river, which has shifted eastward.
CHAPTER II

CLIMATE

The climate of Budaun and Shahjahanpur districts is characteristically monsoonal with a rhythm of changing seasons. The changes occur with respect to the climatic elements which effectively control the whole agricultural set up and the arrangement of the crop-seasons.

The monsoon climate of the area is characterised by the two air currents of northeast and southwest monsoon, in the winter and the summer months of the year respectively. The reversal of temperature conditions and the pressure of the air takes place twice in the year. The winter monsoon, being continental in origin, is mostly dry, while the summer monsoon being oceanic in origin, is moisture laden. The winter rains always remain lesser than the summer monsoon rains.

The most decisive factor for the agricultural operations in the area under review is the summer monsoon rainfall which affects the water supply round the year. The low temperatures and the gentle pressure-gradients during the winter months are accompanied by weak winds, while during the summer monsoon season, the high temperatures in the area with intensive heating of northwest India, produce steep pressure-gradients resulting in strong winds with jet monsoon stream rushing from the east-southeast in the area.

The cropping seasons—kharif and rabi—are closely related to the summer and winter monsoon seasons, and the abnormal weather conditions in these seasons, particularly rainfall, have great effects upon the agricultural operations of the area.

The dry part of the year, November to middle of June, is divided into the cold weather season and the hot weather season: the former corresponds with the season of *rabi* crops while the latter is completely dry which does not allow cultivation except few insignificant *zaïd* crops consisting of melons, water-melons and cucumbers in dry river-beds.

The wet summer season comprises the remaining months of the year, i.e., from mid-June to October, which correspond with the kharif season. Thus the generally recognized three seasons of the year in the area are:

1. the cold weather season (November to February)
2. the hot weather season (March to mid-June) and
3. the season of rains (Mid-June to October)

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1. The writer has followed the generally recognized division of the year which corresponds with the agricultural seasons of the year.
2. India Meteorological Department has divided the year into four seasons:
   a) The season of the northeast monsoon:
      i) January and February—Cold weather season;
      ii) March to mid-June—hot weather season;
   b) The season of the southwest monsoon:
      i) Mid-June to mid-September—season of general rains;
      ii) Mid-September to December—season of retreating monsoon.
3. October is the transitional period when the cessation of the summer monsoon rains occur and, with the decrease of temperature and increase of air pressure, the month receives the season’s least rainfall but, as the month is included in the kharif season which mostly corresponds with the season of rains, the writer has, for the sake of convenience, included it in the season of rains.
The Cold Weather Season (November—February)

The temperature begins to decrease in November and is lowest in December and January, but it slightly increases in February at all stations of the area (Fig. 6).

It will be seen from Fig. 6 that the mean minimum temperature in the month of November at Aligarh, Bareilly, Shahjahanpur and Hardoi ranges from 10 to 12 °C, but the mean maximum temperatures at these stations range between 27 and 29 °C. December registers a further decrease both in the mean minimum as well as mean maximum temperature. The mean minimum temperature ranges from 7.6 to 8.8 °C, while the mean maximum shows a drop of 4 to 5 °C at all the stations (as compared to the preceding month).

The days in December are less warm and the nights are cooler than November.

January is the coldest month of the year and records the lowest temperature. The mean minimum temperature in this month at above-mentioned stations ranges between 7 and 8.5 °C, while mean maximum temperature ranges between 21 and 22 °C. In February, the temperature begins to increase everywhere. The days are warm but the nights are cool in this month.

1. Temperature began to be recorded in Shahjahanpur since 1954. Prior to this there were no arrangements of temperature records at any of the stations. Although Aligarh (in the southwest), Bareilly (in the north) and Hardoi (in the southeast of the area), are at a distance of 44, 20 and 35 kilometres from the area respectively, the conditions there are very similar to those of Budaun and Shahjahanpur districts. There is no other observatory in the area. The temperatures given for Aligarh, Bareilly and Hardoi in the Chapter cover an average of over sixty years. The data have been taken from the India Meteorological Departments (New Delhi & Poona) and the District Headquarters and have been computed by the writer.
MEAN MAXIMUM, MEAN MINIMUM AND MEAN MONTHLY TEMPERATURES

STATIONS BAREILLY, SHAHJAHANPUR, ALIGARH & HARDOI

SOURCES
1. NORMALS OF TEMPERATURE FOR UTTAR PRADESH STATIONS BASED ON ALL DATA UPTO 1960, INDIA METEOROLOGICAL DEPTT (NEW DELHI) UNPUBLISHED.
2. ANNUAL SUMMARY OF TEMPERATURE FOR UTTAR PRADESH STATIONS, 1961, INDIA METEOROLOGICAL DEPTT (NEW DELHI) UNPUBLISHED.
3. ANNUAL SUMMARY OF TEMPERATURE FOR SHAHJAHANPUR, 1955 TO 1963, INDIA METEOROLOGICAL DEPTT (POONA) UNPUBLISHED.

FIG. 8
The westerly winds, being a cold and dry air mass, are determined partly by pressure distribution and partly by the trend of Himalayan relief. They blow from northwest to southeast on the Gangetic plain.

During this season, the velocity of the wind is least in November but gradually increases with the advance of the season. During the months November to February, the velocity ranges from 1.5 km. to 5.6 km. per hour at the above mentioned stations.

A significant climatic feature of this season is the occurrence of frost which adversely affects some crops. Arhar (pigeon peas), peas and gram are most susceptible to its adverse influence. There are, however, no definite records of frequency of frost. Both fog and frost are liable to occur mostly in the coldest months, December and January. The fog usually occurs after a winter precipitation and lasts for a night or two; but the frost being very dry and cold lasts for two or more nights and mornings and is generally followed by precipitation.

Once the cold dry air has set in, further formation of fog or mist is inhibited. As the western disturbances move eastwards, the fog region travels along the submontane and canal districts of Uttar Pradesh, including the area under review.

1. Normand, C.W.B. Climatological Atlas for Airmen (Poona, 1943), p.10
2. Based on the records of wind velocity— India Meteorological Department (New Delhi), unpublished, computed for all data upto 1960. No record of wind velocity at Budaun and Shahjanpur is available.
3. The fog is locally known as Kohra while the frost as 'pala', which is cooler than the kohra. The data of air pressure, direction of winds and the number of days of fog have been taken from Normand, C.W.B., Climatological Atlas for Airmen, (Poona, 1943).
4. Technical Notes, No.1, India Meteorological Department, (Bombay, 1943), p.9.
It is remarkable that the proportion of cloud as well as the relative humidity in the month of February are higher at the northern station (Bareilly) than at the southern stations (Aligarh & Hardoi).

It will be seen from Fig.8 that the amount of cloud gradually increases from November to the end of February in the northern and southern parts of the area, (Aligarh and Bareilly) while the clouds in the eastern portion begin to decrease from early February as at Hardoi. It is remarkable that both clouds and the relative humidity in February are relatively high at the northern station, Bareilly, than the southern stations, Aligarh and Hardoi.

During the season, the relative humidity at 8:30 and 17:30 hours remains least in November, being 50 and 49 per cent at Aligarh, 74 and 59 per cent at Bareilly and 75 and 50 per cent at Hardoi, (Fig.8). It gradually increases to 65 and 62 per cent, and 81 and 65 per cent, and 86 and 65 per cent in January at the respective stations. In January it generally increases but again decreases in February.

The months of January and February are also characterised by some rainfall (Fig.7) which, according to some writers, occurs owing to winter depressions. Most of these depressions are supposed to originate in the Mediterranean Sea and some as distant as Western Europe and some secondaries

1. The data of cloud proportion (Octas) and the relative humidity have been taken from the unpublished records of the India Meteorological Department (New Delhi); the given data cover a normal of all the years up to 1960.
BUDAUN AND SHAHJAHANPUR
DISTRICTS
AVERAGE MONTHLY RAINFALL

SOURCE
1. MEMOIR OF INDIA METEOROLOGICAL DEPT. VOL.XXI PT. III (DELHI 1962) FOR YEARS 1901-1950;
2. MONTHLY AND ANNUAL RAINFALL TABLES FOR 1951-1955, GOVT. OF U.P., LUCKNOW;

THE FIGURES INDICATE AVERAGE MONTHLY RAINFALL IN MILLIMETRES.
THE AVERAGES FOR MOST OF THE STATIONS ARE OF OVER SIXTY YEARS.
SOURCE
1. NORMALS OF CLOUDS FOR U.P. STATIONS BASED ON ALL DATA UPTO 1960, I.M.(NEW DELHI), UNPUBLISHED;

Percentage of Humidity at 8:30 hours
Percentage of Humidity at 17:30 hours
over Iran and move towards the east and come as far as the mid-Gangetic Valley. Others believe that a fragment of the polar front is to be found in northwestern India—Pakistan where northwesterly continental air invades the realm of the Indian Trades. Not infrequently these westerlies and their front extend well down the Ganga Valley. Weak depressions develop along the front in northern India, providing a modest amount of winter rainfall.

Still there are others who believe that the Indian monsoon is closely connected with trade winds of the northern hemisphere and say that the high pressure zones formed in the northern part of India play an important role in the origin of the winter monsoon in India.

But although the winter rainfall of the western disturbance is largely confined to northern India-Pakistan, individual storms, during the passage from the Punjab to Bengal, involving three to five days, may produce very different rainfall patterns. The precipitation generated by these western disturbances of the cooler seasons is usually fairly widespread and light to moderate.

5. Trewartha, G.T., op.cit., p.156.
The winter rains\textsuperscript{1} are important for \textit{rabi} crops. But the failure or deficiency of winter rainfall does not as much harm the \textit{rabi} crops as the deficiency and delay of summer monsoon rainfall to the \textit{kharif} crops.

The stations nearer to Himalaya in the area have greater winter-precipitation than others. Fig. 9 shows that northern stations of Bisauli, Pawayan and Khutar receive greater precipitation in winter than the southern stations of Sahaswan, Gunnaur and Jalalabad which have the least amount of winter-precipitation.

The precipitation of the cold weather season in any year is directly related to the number, intensity and character of the storms of the period, and the precipitation occurs almost exclusively during storms or depressions.\textsuperscript{2}

The total seasonal rainfall varies from 39.3 millimetres at Gunnaur to 56.0 millimetres at Pawayan and 57.7 millimetres at Bisauli, (Fig. 9).

The number of rainy days ranges on an average from 1 to 1.5 in a month. The number of total rainy days in the season is, however, greater at the northern stations of Bisauli and Pawayan than at the southern stations. The thunderstorms are sometimes accompanied with hail which often destroys standing \textit{rabi} crops.

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1. The data of precipitation in all months and all stations have been taken from the:
   i) Monthly rainfall statistics, published for various years by the Govt. of Uttar Pradesh, (Lucknow);
   ii) Unpublished records—Indian Meteorological Department (New Delhi) a
   iii) Unpublished records, District Headquarters of Budaun and Shahiapanpur. The averages are of over sixty years.
BUDAUN AND SHAHJAHANPUR DISTRICTS
AVERAGE RAINFALL
AND
AVERAGE NUMBER OF RAINY DAYS
NOV. - FEB.

FIG. 9

SOURCES
1. MEMOIRS OF THE INDIA METEOROLOGICAL DEPTY VOL. XXI
   PART III (DELHI, 1962)
2. MONTHLY AND ANNUAL RAINFALL TABLES FOR YEARS 1931/1932
   GOVT. U.P. LUCKNOW
3. TABLES OF THE WEEKLY AND MONTHLY RAINFALL AND OF RAINY
   THE FIGURE BESIDE EACH STATION INDICATES AVERAGE RAINFALL IN
   MILLIMETRES FOR THE MONTHS OF NOV. TO FEB. THE AVERAGES FOR MOST OF
   STATIONS ARE OF OVER SIXTY YEARS.

KILOMETRES
The Hot Weather Season (March–mid-June)

The temperature begins to increase continuously from March. In this month the mean monthly temperatures at Aligarh, Bareilly, Shahjahanpur, and Hardoi, range from 22.6° to 23.7° C. The mean minimum temperatures at these stations vary between 14.6° and 15.6° C, and the mean maximum temperatures are between 30° and 32° C.

The temperature in April increases at these stations with the mean minimum from 20.0° to 20.6° C, and the mean maximum from 35.9° to 37.9° C. The mean monthly temperature of this month ranges between 27.9° and 29.2° C, at the respective stations.

The temperature attains its climax in May. The mean maximum temperature at the above mentioned stations in May is between 39.5° and 41.1° C, and the mean minimum ranges from 24° to 26° C, while the mean monthly temperature ranges between 31.9° and 33.5° C (Fig.6). The excessive temperature conditions often continue up to mid-June till the advent of the summer monsoon. High temperature leads to intense dryness and extremely hot weather.

The relative humidity is 30 to 44 per cent at 8-30 hours and 28 to 31 per cent at 17-30 hours in April, and 32 to 46 per cent and 26 to 30 per cent at the respective times in May. At Hardoi, it is 79 and 36 per cent respectively in March but these percentages reduce to 41 and 31 in April, and 43 and 26 at the respective times in May. The relative humidity during this season remains always lesser than in any other season (Fig.8).

The most piercing hot winds known as 'loo' are the most pronounced westerly winds, which contain little moisture. Their strength is subject to considerable diurnal variations.

The loo blows during the day with a normal speed\(^1\) of 8 to 9, 4.7 and 7.4 kilometres per hour at Aligarh, Bareilly and Hardoi respectively. They are comparatively feeble at night and active during the day, being forceful in the afternoon generally from noon to 4.00 p.m. when the humidity occasionally falls to as low as 2 or 3 per cent. The 5 per cent humidity has occasionally been recorded explaining extreme dryness.\(^2\)

The occurrence of dust storms known locally as 'andoi' also form an important feature of this season, particularly of the latter half. The 'andoi' raises a huge cloud of dust which prevails over the sky within minutes. It occurs due to abnormally high temperature and least air pressure with hot calm atmosphere. Generally it comes in the afternoon or the evening, and occasionally at night. It often blows with an abnormal velocity of 30 to 50 kilometres per hour. It comes with the force of a gale, perturbing people and completely disturbing their outdoor activities.\(^3\) It becomes uncomfortable to breathe and much painful to the eyes in the open.

It can blow down trees and thatched roofs. These winds raise clouds of dust with which the whole lower atmosphere becomes surcharged, and which give a peculiar reddish yellow glare to the sunlight, more especially in the afternoon hours. The huge mass of dust is carried generally for long distances probably as much as a hundred kilometres, reducing visibility to 3 or 4

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1. The wind speed computed on the basis of all records available upto 1960—unpublished—Indian Meteorological Department, (New Delhi).
metres. The dust storm is sometimes followed by a little rainfall modifying the weather for a short period.

The rainfall in March is generally prejudicial to the ripening rabi crops. The total rainfall of the season varies from 27.5 millimetres (Gunmaur) to 40 millimetres (Khutar) while the season's total number of days of rainfall are 2 or 3 only (Fig. 10).

The high temperatures, low humidity and cloudless skies of March and April favour the ripening of rabi crops, after which they favour their harvesting, threshing and winnowing. The increased wind speed in April and early May helps much in winnowing the cereal grains. The cultivation is then stopped till the advent of the next monsoon rainfall, as the vegetative growth in the latter half season is hindered due to desiccating effect of excessive hot-dry weather conditions.

The Season of Rains\(^1\) (Mid-June to October)

With the 'burst' of the monsoon the weather changes. In the month of June, the mean maximum temperature at Aligarh, Bareilly, Shahjahanpur and Hardoi varies from 37.9\(^\circ\) to 39.6\(^\circ\) C. and the mean maximum temperature ranges from 26.7 and 28.1\(^\circ\) C. The mean monthly temperature of this month ranges between 32.4 and 33.6\(^\circ\) C.

1. The season of rains is locally known as 'varsha ritu' or barsat.
BUDAUN AND SHAHJAHANPUR DISTRICTS
AVERAGE RAINFALL
AND
AVERAGE NUMBER OF RAINY DAYS
MARCH – MID-JUNE

SOURCES
1. MEMOIRS OF THE INDIA METEOROLOGICAL DEPT. VOL XXXI
   BY SI (DELHI 1963).
2. MONTHLY AND ANNUAL RAINFALL TABLES FOR YEARS 1951 TO 1955
   GOVT. UP LUCKNOW.
3. TABLES OF WEEKLY AND MONTHLY RAINFALL AND OF RAINY DAYS RECORDED
   AT THE DIST HEADQUARTERS FOR THE YEARS 1956 TO 1962.
4. THE FIGURE BESIDE EACH STATION INDICATES AVERAGE RAINFALL IN MILLIMETRES
   FOR THE MONTHS OF MARCH TO MID-JUNE. THE AVERAGES FOR MOST OF THE STATIONS
   ARE OF OVER SIXTY YEARS.

FIG. 10
Each of the mean maximum, mean minimum and mean monthly temperatures (Fig. 6) has a gradually continuous fall from June to the end of August at all stations. The mean maximum temperature in September shows a little increase from August, but the mean minimum temperature records a decrease.

There is a continuous decrease of mean monthly temperature from June to October at all stations; it is also accompanied with the continuous decrease of mean minimum temperature at these stations.

The daily range of temperatures during the summer monsoon varies from 7 to 15°C at these stations. The daily range of temperatures remains always least in August at all stations, while the range is large in June and October. The maximum range is, however, recorded in October, being about 13° to 15°C at these stations.

During the normal monsoon months the monsoon trough running from east to west brings about general and heavy rains with prolonged raining winds. They are often in association with shallow depressions which travel slowly westwards towards the main monsoonal low. The thunderstorms accompany squall winds and make the weather turbulent.

The proportion of clouds during this season is the highest of the year (Fig. 8). The proportion of clouds is maximum in July and August at all stations. The southern stations of Aligarh and Hardoi get a lower amount of clouds than the northern, Bareilly. The cloud amounts in June are 2.3 to 3.3 octas at these stations. This amount increases in July, being 4.8 to 5.8 octas, and in August being 4.6 to 5.9 octas at these stations. This amount decreases in September being 2.6 to 3.3 octas.

During the season, the hailstorms, fog or frost are entirely absent. The relative humidity increases from June to August at all stations.

A comparison of relative humidity at different stations shows that in each of the months from July to October it remains generally larger in the southeast of the area (Hardoi) than the northern or western stations (Bareilly and Aligarh). Secondly, it is the largest at all stations in the months of July and August—the period of growth of the kharif crops.

The jet monsoon stream, characterised by heavy and prolonged rainfall is a large scale inflow of moist maritime air. It gives widespread rains over most of the area (Fig.11). The setting in of the monsoon rainfalls is not equal in all parts of the area. The time of its occurrence at various places may also vary. The average rainfall in the season varies from west to east in the area being below 700 millimetres in the west (629 m.m. at Gunnaur) and above 1000 m.m. in the east (1075 m.m. at Pawayan).

Unequal distribution of rainfall and unequal rainless periods are not uncommon. The variable rainfall conditions greatly affect the cropping conditions. Sometimes very heavy rainfall is experienced in this season; sometimes it is scanty in the time of need. For example, in the period of crops' growth—June to August—it was 866.8 millimetres in 1961 at Gunnaur where, during the same period, it was only 380.9 millimetres in 1962. At the same place, it was 214 millimetres in September and October in 1961—the period of ripening of kharif crops, but during this period in 1962, it was 420 millimetres. The same phenomenon is seen at Pawayan where the
BUDAUN AND SHAHJAHANPUR DISTRICTS
AVERAGE RAINFALL
AND
AVERAGE NUMBER OF RAINY DAYS
MID-JUNE - OCTOBER

RAINFALL

NUMBER OF RAINY DAYS

Below 700 mm
30

700-800
33-35

800-900
35-37

900-1000
38

above 1000
39

SOURCE
1. MEMOIRS OF INDIA METEOROLOGICAL DEPT. VOL. XXXI PT. III (DELHI 1962);
2. MONTHLY AND ANNUAL RAINFALL TABLES FOR YEARS 1951 & 1955, GOVT. U.P. LUCKNOW;

FIG. 11
rainfall in the months of June to August was 681.6 millimetres in 1959, but next year it was 1142.6 millimetres during these months collectively. At the same locality, it was 56.4 millimetres during September and October, 1959, while it was 996 millimetres during these months of 1960.

The total of summer monsoon rainfall at Shahjahanpur was 1323 millimetres in 1961; but the next year it remained only 659 millimetres, when the average of the seasonal rainfall is 949 millimetres. At Tilhar, the seasonal total rainfall in 1959 was 652 millimetres but in 1960, the total of the season was 1734.6 millimetres being nearly double of the seasonal average rainfall (891.5 millimetres). The seasonal rainfall was 516.5 millimetres more than average at Shahjahanpur in 1949 while in 1951 it was 335 millimetres lesser than the seasonal average.

During the rainy season, rainless periods can occasionally last for many weeks also.

The 50 to 60 per cent rainfall of the year, on an average, occurs in only July and August in the area.

The summer monsoon rainfall decreases from early September when the monsoon becomes weaker at all stations.

In October the mean monthly temperature ranges between 24.7° and 26.0° C. at Aligarh, Bareilly, Shahjahanpur and Hardoi; the mean maximum temperature lies between 31.2 and 33.7° C., while the mean minimum temperature varies between 18.3 and 19.7° C. By the retreat of monsoon from northwest to southeast, the rainfall in October on an average is 30 and 63 millimetres at Gunnaur and Khutar, the western and eastern stations of the area. (Fig.7).

It will be worthwhile to see the frequency of annual heavy rain in the area. The frequency of heavy rainfall at different stations in the area is shown in Table I.
<table>
<thead>
<tr>
<th>Stations</th>
<th>No. of years</th>
<th>76 to 102</th>
<th>102 to 127</th>
<th>127 to 152</th>
<th>152 to 178</th>
<th>178 to 203</th>
<th>203 to 229</th>
<th>229 to 254</th>
<th>254 to 279</th>
<th>279 to 305</th>
<th>305 to 330</th>
<th>330 to 356</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gunnaur</td>
<td>30</td>
<td>20</td>
<td>6</td>
<td>4</td>
<td>1</td>
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<td>.</td>
<td>1</td>
<td>.</td>
<td>1</td>
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<td>30</td>
<td>21</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>.</td>
<td>1</td>
<td>.</td>
<td>1</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Bissuli</td>
<td>30</td>
<td>29</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>.</td>
<td>1</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Budaun</td>
<td>30</td>
<td>23</td>
<td>6</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Dataganj</td>
<td>30</td>
<td>33</td>
<td>17</td>
<td>9</td>
<td>1</td>
<td>2</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Tilhar</td>
<td>30</td>
<td>34</td>
<td>12</td>
<td>6</td>
<td>.</td>
<td>.</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>.</td>
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<td>.</td>
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<tr>
<td>Jalalsbad</td>
<td>30</td>
<td>25</td>
<td>11</td>
<td>1</td>
<td>.</td>
<td>1</td>
<td>1</td>
<td>.</td>
<td>.</td>
<td>1</td>
<td>1</td>
<td>.</td>
</tr>
<tr>
<td>Shahjahanpur</td>
<td>30</td>
<td>28</td>
<td>16</td>
<td>11</td>
<td>4</td>
<td>1</td>
<td>1</td>
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<td>1</td>
</tr>
<tr>
<td>Pawayan</td>
<td>30</td>
<td>32</td>
<td>18</td>
<td>8</td>
<td>1</td>
<td>2</td>
<td>1</td>
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<tr>
<td>Khutari</td>
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<td>.</td>
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</tr>
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</table>

It will be seen from the Table I that the frequency of heavy rainfalls is lesser in the first five stations (of Budaun district) lying in the west, than the last five stations (of Shahjahanpur district) lying in the east. The rainfall with an amount of 254 to 356 millimetres at each occasion is only at two stations of the Budaun district, whereas it is at six stations of Shahjahanpur district. Similarly, the occurrences of rainfall of 203 to 356 millimetres at a time are only five during 30 years at the stations in Budaun district as against twelve such occurrences during the same period at the eastern stations of Shahjahanpur district. This shows that Shahjahanpur district is wetter than Budaun and the relative wetness of this district has led to higher proportion of land being devoted to sugarcane and rice in this district than in Budaun.

VARIABILITY OF RAINFALL

Over 27 per cent is the mean annual variability in the western part of the area under review while it is below 21 per cent in the centre of the eastern half of the area. A comparison of average annual rainfall and the mean annual variability (Figs. 12 and 13) shows that the western portion where the rainfall is less, has proportionately higher tendency to deviation from the average than the eastern portion where rainfall is relatively high. The area of largest percentage of mean annual variability corresponds to the area of the least rainfall in the summer monsoon months, mid-June to October, (Fig. 11), as well as to that of least annual rainfall (Fig. 12). The figures 14 to 23 express the variation in annual rainfall from the average over a period of thirty five years (1928-1962) for stations maintaining
BUDAUN AND SHAHJAHANPUR, DISTRICTS
AVERAGE ANNUAL RAINFALL

SOURCE
1. MEMOIRS OF INDIA METEOROLOGICAL DEPARTMENT
   VOL. XXXI, PART III (DELHI, 1962) FOR THE YEARS 1911 TO 1950;
2. MONTHLY AND ANNUAL RAINFALL TABLES (GOVERNMENT OF UTTAR PRADESH,
   LUCKNOW) FOR THE YEARS 1951 TO 1955;
3. DATA OF MONTHLY RAINFALL RECORDED AT THE DISTRICT HEADQUARTERS
   FOR THE YEARS 1956 TO 1963

THE AVERAGES FOR MOST OF THE STATIONS ARE OF OVER SIXTY YEARS.

FIG. 12
SOURCE

The percentages have been computed by the writer on the basis of monthly rainfalls of Uttar Pradesh - for the years 1928-1955, and the data of monthly rainfall recorded at the district headquarters for the years 1956-1962.

FIG. 13
rainfall records. The winter rains are generally heavier when the total fall of the year is below the mean, than when the summer rains are excessive. The whole of the area under review is susceptible to famine as annual variability of more than 12 per cent makes an area susceptible to famine. The total rainfall at different stations has generally large variations from the average from place to place as well as from year to year, which is practically a common feature due to fluctuating character of summer monsoon rainfall. For instance, the annual rainfall in 1930 was 948.2 millimetres at Sahaswan which is above the average, while in the same year it was below annual averages at Bisaulli, Gaurnur, Budaun, Tilhar, Shahjahanpur, Pawayan and Khutari being 832.6, 483.1, 718.8, 946.7, 805.9, 982.5 and 1044.2 millimetres respectively. Similarly in 1940, the rainfall was 1041.4 millimetres at Pawayan, being below the average, when it was 1172.2 and 1320.6 millimetres at Shahjahanpur and Khutari, being above their averages in the same year. It was below average in 1962 at all stations except Budaun and Pawayan.

The variability of rainfall exists also from year to year at a place. If the rainfall in one year is on the average, it is liable next year to be below or above average. The annual rainfall, for example, at Bisaulli was below average in 1962 while in the preceding year it was more than double of that amount (Fig.14). The rainfall at Budaun or Khutari in 1936

ANNUAL RAINFALL
(1928-1962)

MILLIMETRES
2500
2000
1500
1000
500
250

BISAULI

Fig. 14

SAHASWAN

Fig. 15

GUNNAUR

Fig. 16

BUDAUN

Fig. 17
was more than three times greater than what it was in the preceding year (Figs. 17 and 23). This climatic phenomenon can be seen at any rainfall station. The monsoon activity and the distribution of rainfall are liable to considerable variations.

It can be seen from Figures 14 to 23, that the rainfall in a given year is more than enough at a place causing flood conditions while at another place it may be lesser or on the average in the same year. In 1959 the rainfall was below average at all stations except Budaun where it was more than the average. The years 1928, 1932, 1937 and 1951 had experienced very deficient rainfall at all stations, while 1936, 1958, 1960, 1961 were the years of largely greater rainfall than the average at all stations, and were very wet years.

Variability in the Season of Rains

The timely distribution of rainfall is most significant from agricultural point of view. If the rainfall in the rainy season is greater than the average but most of it occurs in September, it will cause much harm to \textit{kharif} crops and may lead to floods. Similarly, if the annual total rainfall is above the average, but the months of June and July receive insufficient rainfall, the \textit{kharif} crops will be much affected, and the delayed sowing or the crop sown already will be physically defective in both quality and the yield. In the same way, the shortage of rainfall in August also harms the rice and sugarcane crops.

\begin{quote}
'\textit{The lower rainfall is accompanied by increased vicissitudes.}'
\end{quote}

ANNUAL RAINFALL
(1928-1962)

MILLIMETRES

DATAGANJ

JALALABAD

TILHAR

SHAHJAHANPUR

Fig. 18

Fig. 19

Fig. 20

Fig. 21
ANNUAL RAINFALL
(1928–1962)

Fig. 22

Fig. 23

SOURCE
FIGURES 14—23 ARE BASED ON ANNUAL RAINFALL STATISTICS PUBLISHED BY THE GOVERNMENT OF UTTAR PRADESH.
The moderate rainfall in September and October is useful for the coming 
*rabi* crops, while excess or the premature cessation of rainfall affects 
partly *kharif* crops and mostly *rabi* crops, causing postponement or 
restriction of the sowing of *rabi* crops. The September rainfall in 1941 
was 33.5, 50.8, 55.6 and 55.4 millimetres at Gunnaur, Budaun, Pawayan and 
Khutar, while in September 1942 it was 151.9, 121.4, 121.9 and 200.2 milli-
metres at these stations respectively. Flooding in September 1942, provided 
the adequate moisture for vigorous germination in the next *rabi* season; this ensured 
seed germination in the following *rabi* season in a soil well—supplied 
with moisture.

In any case, no single value of rainfall data, however, determined, 
can give a complete descriptive summary, and the frequency of departures 
from the normal is important, but the average is particularly at fault.
Therefore, the mean monthly variability of rainfall for each of the wet 
monsoon months has been given in the Table II.

It will be seen from Table II that the percentages computed by the 
median values (as in Table II B) are sometimes largely different from those

1. Clark, K.G.T., The Vicissitudes of the Summer Rainfall of the Indo-
p. 288.
2. Parr, C.H., 'Flood Water Farming', *Indian Farming* Vol.IV, No.10,(Delhi, 
   October, 1943), p. 513.
3. Crowe, P.R., The Analysis of Rainfall Probability, A Geographical Method 
   and its Application to European Fata, *Scottish Geographical Magazine*, 
   (Edinburgh, 1933), Vol.XLIX, pp. 74-75.
TABLE II

<table>
<thead>
<tr>
<th></th>
<th>June %</th>
<th>July %</th>
<th>Aug.%</th>
<th>Sept.%</th>
<th>Oct.%</th>
<th>June %</th>
<th>July %</th>
<th>Aug.%</th>
<th>Sept.%</th>
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<td>A</td>
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<td></td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
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DISTRICT BUDAUN

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<th>Dataganj</th>
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<td></td>
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<td>44.1</td>
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DISTRICT SHAHJAHANPUR

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<th>Shahjahanpur</th>
<th>Pawayan</th>
<th>Khutar</th>
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<tbody>
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<td>67.3</td>
<td>62.6</td>
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<td>31.3</td>
<td>36.3</td>
<td>27.0</td>
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<td>166.0</td>
<td>381.4</td>
<td>224.1</td>
<td>136.7</td>
<td>277.6</td>
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</tbody>
</table>

1. The figures have been computed by the writer on the basis of monthly rainfall statistics of thirty five years (1928-62) of each rainfall station. The Monthly rainfall figures are published by the Government of Uttar Pradesh, Lucknow. The Tables IV A and IV B have been computed on the Mean Value method and the Median value method, as given by P.R. Crowe, op., cit., pp. 77-78.
(of Table II A) computed by the Mean Value method, particularly in October, September and June. It is because the median is not necessarily at the half way point, since the range of variation is greater upwards than downwards, as against the half interquartile distance or mean value method (Table A). However, the Table II B gives the maximum limit of variability experienced particularly in October at most of the stations. There is no median value or the lower quartile value of rainfall in October at the Gunnaur station, hence the variability is 73.5 per cent in the Table (II B).

The above Tables show that the variability is least in July and August being below 45 per cent at all stations and as low as 27 per cent at some stations. It is greatest in October everywhere. It is considerably higher in September than June at the stations in Budaun district and the reverse at stations in Shahjahanpur district (Table II A). In June the variability varies from 56 to 74 per cent. In September it ranges between 39 and 79 per cent while in October it is 100 per cent at all stations (Table III A).

Variability from the Median

The average values of rainfall are deceptive particularly when the rainfall in one of the months (or years) is extraordinarily heavy or the least or nil unexpectedly. In such cases the average value increases or decreases unjustly. An occasional high value of no great agricultural

1. Crowe, P.R., op., cit., p. 78.
significance may raise the mean unduly, and thus the ordinary average is insufficiently sensitive and at other times over-sensitive to extreme variations. The median or the middle value of rainfall, actually experienced at a station in an individual month of a long series of continuous years, is located in the middle of the series of various amounts of rainfall put already in ascending or descending order, and this principle formulated by Crowe is a useful indicator of rainfall probability to demonstrate implications of variability.

The variability of rainfall from June to October, therefore, has been analysed with the Median Value Method, comprising all the rainfall stations of the area under review.

The distribution of monthly rainfalls of the wet monsoon months over a period of thirty five years for all the stations has been shown in figures 24–33. It is noteworthy that the stations of Figures 24–27 are situated in the area of maximum annual variability as against the stations of figures 31–33 which possess least annual variability. These groups of stations have varying quartile- and median- values in the same month. Yet all the rainfall dispersion diagrams (Figs.24–33) show similarity of variabilities in various months. These diagrams reveal that the months of maximum rainfall are July and August all over the area. The variability for June, being

1. ibid., pp. 73-74.
greatest at Shahjahanpur, 103.8 per cent (Table IIb), is everywhere
critical due to small median value of rainfall; the June rainfall varies
in the area from nil to 888 millimetres, as in Pawayan. The maximum amount
of rainfall increases generally from west to east in June. The very low
situation of quartiles and medians in June at all stations explains that
most of the years experienced very little rainfall in June. In September,
the interquartile range is fairly long at most of the stations but the
upper quartile and the median value at all stations are largely lower than
in August, which shows a rapid transition with sharp discontinuity between
August and September.

September has generally more variability of rainfall at all stations
than June in which rainfall is more liable to be deficient at stations of
first and second groups, (Figs. 24-27 and 28-30).

The median value and the lower quartile of August are respectively
greater than the upper quartile and median value of September with the
result that August is wetter than September at all stations except Gunnaur
and Budaun where the month of August, which has lower median value than June,
is still most probably wetter than September. The interquartile range
in October is least of all months at all stations experiencing the least
rainfall in most of the years. With the exception of Pawayan, the wettest
station, all the stations have lowest median values without lower quartile
in October, which denotes that at least five or six years had rainless
October, and a large number of years got insignificant rainfall in this
month. The location of median in October generally very close to zero
millimetre or even absent, as at Gunnaur, reveals (i) less probability of rainfall in most of the years and (ii) the greater probability of less rainfall. The October rainfall being as high as 600 or 700 millimetres casually at some stations provides the largest variability of rainfall in this month. The probability of rainfall in October varies from east to west, as the probability of maximum rainfall, experienced at Pawayan, is 700 millimetres which is not more than 250 millimetres at Gunnaur (Figs. 32 and 24).

The stations of the first group (Figs. 24 to 27) being in the western part of the area under review have lesser median and upper quartile values than those of the second group (Figs. 28 to 30), in the respective months. The median values of any month at the stations of the first group do not go up to 250 millimetres while those of the second group are generally near 300 millimetres in July or August. The interquartile ranges, particularly in July and August, possess higher rainfall values and higher values of lower quartiles in the second group than those of the first group, which reveals lower variability— and higher probability of greater rainfall in the second group than in the first group. The rapidity of the transition is with sharp discontinuity between August and September in the second group while it is gradual in the first group in the respective months.

Further, a comparison of the second and the third group of stations (Figs. 28—30 and 31—33) shows that the interquartile range of June in the third group is larger than those of the stations of second group. The upper quartile of June does not reach 150 millimetres in the second group
RAINFALL DISPERSION DIAGRAMS
JUNE - OCTOBER
(1928 - 1962)

MILLIMETRES

1000 -
900 -
800 -
700 -
600 -
500 -
400 -
300 -
200 -
100 -

J J A S O
SHAHJAHANPUR
FIG. 31

J J A S O
PAWAYAN
FIG. 32

J J A S O
KHUTAR
FIG. 33

SOURCE: FIGURES 24 - 33 ARE BASED ON STATISTICS OF MONTHLY RAINFALL
PUBLISHED BY THE GOVERNMENT OF UTTAR PRADESH FOR THE VARIOUS YEARS.
THE ENCIRCLED DOTS REPRESENT THE MEDIAN RAINFALL FOR THE VARIOUS MONTHS AT EACH STATION.
while it goes above 200 millimetres in the third group; similar is the case of median which is far below 100 millimetres in June in the second group while it is on 100 and above in the third group. The upper quartile of July and August in the second group is far below 400 millimetres while it is generally above this limit in the third group of stations which shows that the stations of the third group have still lower variability of rainfall and high probability of greater rainfall in most of the years than the stations of the second group; and it signifies that these months of the third group are the wettest months of the year in all the stations of the area.

The rapidity of transition between August and September is with sharp discontinuity in the second and third groups. But the lower quartile value of September in the third group is generally higher than in the second group. The median value of September is below 150 millimetres in the second group but it is up to 200 millimetres in the third group, which indicates greater probabilities of higher rainfall in September of the third group than that of the second group for most of the years. A comparison of the September median values of the stations reveals that the median value gradually increases station to station from west to east.

The month of October in the third group has larger quartile range and higher median value than those of the stations of first and second groups. The higher median values of each of the months at the stations of third group than those of the other two groups signify (i) greater probability of higher rainfall for most of the years and (ii) the least variability of rainfall in the wet monsoon season.
The variability of rainfall in June largely affects the agricultural operations as late occurrence of rainfall delays sowing of crops. The interquartile range showing variability of rainfall in July and August is less significant from agricultural point of view with regard to (i) much higher values of lower quartile and median and (ii) the highest amounts of total monthly rainfall in these months. The little rainfall in October is useful for the ripening of kharif crops, while its excessive occurrence is injurious.

Thus it will be seen that rainfall in western half of the area is quite variable in those months of the year when its regularity is most needed. Such a variability cannot but lead to uncertainties in agricultural operations.
CHAPTER III
SOILS

Adequate scientific material on the soils of the area are not available. The Settlement Reports of the Districts, District Gazetteers, Assessment Reports and the Revenue Records—the oldest sources of information available to the writer—provide a textural classification of soils. The soil surveys of some scattered areas which have been carried out in recent times provide only a generalized information and do not accurately show the soil subdivisions of the area. The main factor governing the classification of soils for revenue assessment was the texture of the soil. However, soil fertility surveys were not initiated in the area in the past and data of soil analysis are not available for the area.


2. I. Soil Map of India, prepared at Indian Agricultural Research Institute (New Delhi) in Soil Management in India by Arakeri, H.R., Chalam, G.V. and Satyanarayana, P. (Bombay, 1962), p. 2;
II. Survey of India School Atlas, (Dehra Dun, 1964);
During the course of the field work the writer visited a number of villages in different parts of the area and obtained information on the soil fertility, texture and structure, its colour and workability, on the availability of water supply and manure, on the level of the land and on the capacity of soil to retain moisture.

On the basis of this and other existing information, a classification of soils of the area has been attempted and a soil map has been drawn. The soils of the area are alluvial and vary from sand, loam, silt and clay to occasional gravel beds and lenses of peaty matter. These soils vary in composition, texture and productivity; each of them possesses its own peculiarities with almost a homogeneous character in its tract.

According to the physiographical variations of river courses and the surface of the land, the area is divided into the Newer (Recent) alluvium called khadar and the Older (Pleistocene) alluvium called Bangar.

KHADAR

The khadar lands along the rivers of Ganga, Ramganga, Garra and Gomati are low lying long strips of floodplain, where fine sand and silt is deposited whenever the rivers overflow their banks. The appearance and the soil fertility in the khadar lands vary. The prevailing form of soil is sand to silty sand, as the silt is often laid down upon sand. Fine silt is also found in flatter parts.

1. The accuracy of the lines demarcating each type of soil is limited in the absence of any detailed soil survey of the area. The map of the soils is based on informations available from the sources referred to above.
The khadar rivers spread sand, silt and mud, generally grey in colour, over vast khadar lands. But the clayey silt is the dominant texture of the soil in the Ramganga khadar. The sandy soil is utilized for the cultivation of millets, pulses sugarcane and rice (broadcast) in the kharif, and wheat, barley and peas in the rabi season. These crops in the khadar are unirrigated, even sugarcane is not irrigated, as the underground water-table generally remains very near the ground, about half to one metre below the surface. The khadar land is a good reservoir of under-ground water. The Ganga-khadar, south of the Mahawa, 16 kilometres west of its confluence with the Ganga, has richer soil in fertility than that of the northern portions. In this portion the soil is annually silted and is locally called bela which is quite fertile. When a khadar soil is overdrained like that in the Ramganga khadar, it is called patka, but the land with the clayey subsoil, as in the northwestern and northeastern portions of the Ramganga khadar, is locally known as khaoat. However, at places, the stretches of waste lands and usar with dhak and tamarisk trees are also found in the khadar lands of the area under review.

The sandy soil along the upper part of the Gomati, and especially on its left bank, is poor with waste lands and wild shrubs, and this is one of the worst parts of the Shahjahanpur district. But the very fertile silty and sandy soil of river Garra (Deoha) khadar provides good opportunities of cultivation, especially without irrigation in the vicinity of the river, and with irrigation at some distance.

The Soils of Bangar Land: The Bangar soils vary from sandy bhur to clayey loam. They vary in colours also as well as in character. The bhur soil is generally of pale reddish brown colour while the sandy loam is of brown colour and the loams are grey or ash grey. The clayey loam soil has a dark grey colour. The gravel and conglomerates may be found in the older alluvium and not in any khadar soil. In the Budaun district, the kankar predominates in the bangar lands particularly at higher levels and these lands remain as waste land. The impervious layer of kankar may either be continuous or intermittent within the soil. The kankar pebbles may be mixed with the cultivated soil also. If the kankar layer lies half a metre or more than under the cultivated soil, it does not much harm the growth of certain crops having shallow roots. It is noteworthy that the proportion of the land containing kankar is quite lesser in Shahjahanpur district than the Budaun district.

But most of the land containing kankar are of either sandy loam, bhur or clayey loam tracts. The size of the kankar varies from place to place. However, it is not found everywhere. Most of the cultivated lands, in general, remain often free of kankar, as in the tract of loam soil.

Unlike the khadar soils, the soils of the bangar possess stable conditions with regard to texture, fineness and fertility; the fine soil-particles and the humus content can retain water for a longer time.

2. The size of the kankar nodules varies from a grain of pulse of lentil to as a man's head, or even more.
I. The Sandy Soil (Bhur): 1 One of the banger land soils, the bhur has an unusual geomorphic feature that adds a variety to the rather monotonous landscape. Its sandy ridges with a flat top and gentle lateral slopes extend into the Budaun district from northwest to southeast, being roughly parallel to the Ganga. But there is no bhur area in the Shahjahanpur district. The continuity of the bhur belt is broken by the Rainsaur river. The sand deposits of bhur tract possess upland areas with an undulating surface feature. Yet the soil under cultivation has not the only sand, and it consists of a poor humus content in the texture. This is due to the fact that the soil has undergone several stages and degrees of oxidation. 2 It is likely that the Ganga has been flowing in the past upon the land now occupied by the bhur belt and the shift of the river from northeast to southwest might have been due to increased alluviation in the Recent. In the southwest of Budaun district, the Ganga---that flows roughly parallel to the bhur belt---, does more lateral corrasion on its right bank than the left, and makes more deposition on its left bank than on the right.

It is also likely that these are deposits of blown sand and fine dust, stretching upon vast tracts of land, mostly devoid of big trees and with occasional patches of dry grasslands. The bhur soil mostly suffers from inadequate supply of plant-food, as the soil is, for the most part, devoid

1. The local names of the soils have been given in brackets. These names given by the farmers to their soils, are descriptive and tell with a reasonable degree of precision the agricultural properties of the soil---Viswanath, R. and Ukil, A.C.—Comparative studies on Indian Soils, Indian Journal of Agricultural Science, Vol.XIV, Pt.V, (Delhi, Oct., 1944) p. 304.

FIG. 54

BUDAUN AND SHAHJAHANPUR DISTRICTS
SOILS

SOURCE:
1. SETTLEMENT REPORTS AND GAZETTEERS OF THE DISTRICTS OF BADAUN & SHAHJAHANPUR;
2. ASSESSMENT REPORTS (DISTRICT HEADQUARTERS), UNPUBLISHED;
3. FIELD WORK BY THE WRITER.
of organic matter. The deficiency of humus content in the soil is coupled with the deficient water supply, as it is commonly underdrained soil. It has little power of retaining moisture and is dry, loose and poor in productivity. It consists of about 90 per cent sand while clay particles are always less than 6 per cent.

The thatching grasses, known as sarkara, poola and sarwa, the noxious weeds known as kang, dry shrubs, called memri, and only a few occasional trees are the only natural vegetation. It was until recently a somewhat negative tract mostly, but now it has partly been reclaimed through some manuring and irrigation with masonry and non-masonry wells. This soil tract receives little rainfall during the months of rains.

The chief crops grown in this tract are millets and pulses, among the grain crops, and the groundnut among other crops of the kharif season, and wheat, barley and peas in the rabi season. The yields are generally very low.

There is a general practice of long-fallowing for one to three years to recuperate the fertility of the soil, and such a long fallowing is not generally practised in any other type of soil. No cultivation is possible without irrigation or manuring. The first class bhur soil with some moisture retaining capacity, known as thandi bhur, is better than the rest two kinds: the 'lokharia bhur'—consisting of high sandy ridges, and the 'urani bhur' comprising the sand brought by the blowing winds. The lokharia bhur on the western edge of the bhur belt overlooking the Ganga valley is the worst part of the tract.

II. Sandy Loam Soil (Katil): The areas occupied by the sandy loam soil lie generally in the western half of each of the districts under review, excepting the khadar belts. The katil belt in Budaun stretches much on both east and west sides of the bhur belt, as well as in the north and south of it. The katil soil, in comparison with the Ganga khadar soils has a smaller percentage of coarse and fine sand and contains a larger proportion of silt and soil-binding clay particles. It contains humus but lesser than loamy soil (katehr). Without irrigation and manuring the soil becomes weak in crop production. It is remarkable that the tract under katil soil mostly has the least annual rainfall in the whole area under review. The underground water table of this soil tract is very low. Hence irrigation is a necessity for agricultural operations here. The calcareous concretion, kankar, is also seldom found. This soil is darker in colour than the khadar or bhur soils.

However, the soil needs seasonal manuring, particularly the farmyard manure, without which irrigation may not be sufficiently useful. The maintenance of soil fertility is best attained by dressings of farmyard manure which has the additional advantage of maintaining the life of micro-organisms such as those which convert organic remains into humus. In a healthy soil it is essential to maintain a supply of organic matter so as to secure a balance between its oxidation which provides carbon dioxide and nitrates and its humification which provides humus and maintains the texture of the soil. But the general practice of the farmers in this belt is to leave most of the cultivated land fallow for recuperating in fertility instead of applying organic manure.

2. ibid., p. 289
The use of masonry and non-masonry wells is mostly prevalent in irrigation. Tube wells are scanty. The main crops are millets, pulses, maize, tobacco and groundnut in kharif, and barley, peas and potato in rabi seasons; sugarcane is also grown where irrigation facilities are present. The sandy loam is ploughed more deeply than loamy or clayey loam soils.

III. Loamy Soil (Katehr): It is the best soil of the area. It contains approximately equal proportions of sand and clay. It is mostly rich in humus and organic matter. In fertility, no other soil can compete it. The colour of the surface soil is grey, with a brownish grey sub-soil. The drainage is good, but irrigation facilities are not adequate. The soil is easily workable and can retain water for a longer period as compared to sandy loam. The underground water table is low. The irrigation facilities are but necessary for agriculture.

The physical aspect of the soil has most important bearing on its fertility, as it provides the environment in which the vital biological activities can proceed in the soil by which nutrient substances are made available to the plant. The practice of fallowing is less in this soil as compared to the sandy loam soil. The production of crops is best where manuring and irrigation facilities are available. The high proportion of organic matter is characteristic of this soil. The kanker is hardly found in this soil tract. The soil, being naturally the most productive, yields good crops of rice, millets and sugarcane in the

and wheat, gram, barley, pulses, peas and potatoes in the rabi season. The largest percentages of good (A) quality lands are in the parchanas of this soil tract. The groundnut, a cash crop, is also commercially produced where irrigation and manuring facilities are not adequate. Irrigation by wells is most prevalent as the temporary (non-masonry) wells can be easily dug.

IV. The Clayey Loam Soil (Matiyar): It is found in both the east and west of the Ramganga in the heart of the area. The least proportion in its texture is of sand and highest is that of the clay particles which is nowhere less than 66 per cent. The matiyar is darker in colour than any other soil. It is mostly grey, the sub-soil being dark grey. The higher parts, though rare, have stiff clay. The kandhar is also sometimes found in the subsoil. The chief physical defects of the clay soil are a too close and coherent texture and inadequate drainage. The activity of micro-organism, upon which the fertility of the soil is dependent, is hampered by either hard or sticky nature of the soil.

The matiyar is better than the bhur soil, it is a second grade soil as compared to the loamy soil (domat). The tract under matiyar soil is flooded in the rainy season and much of the tract is waterlogged, and dampness prevails, but where the conditions are suitable, rice is the chief kharif crop. In comparatively higher or drier parts, millets and kharif pulses are grown; whereas gram, peas and fodder are the rabi crops. The best land for rice crop is known as dhenkar, in which both transplanted rice called jachain and broadcast rice called bhadai are grown profitably.
The matiyar soil is not continuous everywhere in its tract; the loamy or saline usar soils are also found in intervening parts, but to a lesser proportion. Poor drainage and marshy conditions lower the fertility, decrease organic content and increase salinity at places, as the watertable at some places is sufficiently high, at depths varying from half to two metres. Saline or waterlogged parts of matiyar soil have toxic effects on plants and crops. The tract of the matiyar soil is also known at some places as banskati, denoting that it was a forest area in the past. In the vicinity of Ramganga khadar, the soil is clayey loam, while it is calcareous clay far away. It is remarkable that most of clayey loam area is lowland, particularly in the west of Ramganga khadar.

Classification of Soils on the Basis of Fertility

Besides the above classification, the villagers also recognize an alternative system of classifying their lands in accordance with the (I) level of the land (II) location with regard to the village site, (III) presence or absence of salinity in the soil, (IV) and on the basis of varying degree of soil-fertility.

The fields adjacent to the rural dwellings are the best croplands where manuring and irrigation facilities are adequately available. The soil of the land near village dwellings known as gauhan, goind, bara and kachhiana, receives most of the village refuse and compost manure as
well as a good deal of night-soil. The night-soil and the village manure are freely available to the fields adjacent to the village dwellings. The fields a little farther away are manured only occasionally while those situated at long distances from the village site hardly get any manure. The crops found in gaushani soil are most remunerative and most productive; the inferior crops are found farther away. The kachhiana is put to vegetable crops particularly. Rice, sugarcane, fodder crops and vegetables in kharif and wheat, gram, barley, potato and vegetables in rabi are well produced in gaushani soil. The land with a marked slope is inferior in fertility to level land, and is mostly a single-cropped area. The lands with double-cropping and under sugarcane cultivation are the best fertile lands. The cultivated lands which are generally put to fallow for a season or more are the medium quality lands. Nearly all types of soils have this category of land also.

The poor quality lands which do not produce any crop are of two categories, i.e., the baniar and the usar, or the cultivable waste and the uncultivable waste lands. The baniar lands which have wild grasses, bushes and trees are generally put to grazing; thatching grass and fuel material are also obtained from it. But the usar lands have different characteristics.
**USAR SOIL**

The presence of salinity in the soil is injurious to crops. The soil becomes infertile, and is termed as **usar** soil. The distribution of this soil is extremely irregular. The soil is quite different in texture and chemical properties from the adjacent soils. The small pieces of usar lands are often found interspersed with fertile plots. The alkali salts are largely soluble in water. During the wet monsoon months these salts percolate and are deposited in the sub-soil while during the hot weather season the intensive heat exerting a capillary pull brings the water on the surface; the water evaporates leaving a crust of salts.

The toxicity of alkali soils might be directly due to the surface active sodium ions or the action might be indirect due to the physical condition set up in the soil. The usar soil is called **reh** when it is more sandy and powder consists of much alkaline salt. It is called **kollar** when the soil consists of high proportion of clay; but both are deleterious to the growth of vegetation. The kollar land, in addition to containing an excess of salts, is deficient in humus and possibly in bacteria useful to plant life. It is likely that present usar lands might have been agriculturally fertile in old days. Large areas, once fertile and populous, have become impregnated

1. The usar lands are also known as ' **Usra**'.
with these salts and much of the *user* land has resulted within the last few decades; the *reh* is a mixture of sodium carbonate, sulphate and chloride with some calcium and magnesium salts, some of these salts are introduced by river and canal water.¹

The heavy *user* clays of the low land, subject to annual water-logging in the middle of the area, are quite different from the alkaline *reh* efflorescences of the dry area in and around the bhur tract. Some of these soils contain fair amounts of exchangeable sodium.²

Reclamation of *User* Soils: Some of the suitable methods of reclamation are:

- the improvement in drainage, the use of organic manures and green manuring,
- the production of the selected salt-tolerant crops, the use of chemical substances, and the use of irrigation where suitable, in addition to planned crop rotation.

The improvement of land drainage with proper flushing of the salts by excessive water is a useful method, as the washing out of salt from the land through drains for a number of years may reduce the salinity sufficiently.

The best way to reclaim *koller user* is to scrape it onto the irrigation butt, then to irrigate it and again plough it. After it, the *dhup* or *dobra* grass (*Cynodon dactylon*) found there is chopped up and is spread over the land. Afterwards a leveller and a plough furrow and a press are passed over the land. Manuring and irrigation in about six week time will render the soil cultivable.³

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1. Wadia , D.N. Krishnan, M.S. and Mukerji, P.N. *Agriculture and Live-Stock in India*, op.cit., p.80
One of the best sources of reclaiming usar soils is to apply molasses, as the acids produced in the decomposition of molasses neutralise the alkalis. The usar soils are generally poor in nitrogen and humus content. The organic matter in the form of compost and other manures and production of leguminous crops are very useful in its reclamation.

Whenever conditions are favourable, the frequent cropping of high salt-tolerant crops is noteworthy: barley, rape seed, cotton and sugar beet, are the high salt-tolerant crops; while the crops of rice, millets, wheat, maize, pea, linseed and chari (a forage crop) include the medium salt-tolerant crops.

The leguminous crops like groundnut possess a great value in crop rotations, as they usually increase the yield of the successive crops; the increase of nitrogen and micro-biological activity in the soil is their useful result. Crops or plants of abundant foliage prevent the coming-out of the salts from below the surface of the land. The preference should be given to deep-rooted plants and crops which possess great shades; the shallow rooted seasonal crops of little shade like cereals should not be preferred, as after their harvest, the impeded salts rise up again.

The practical method of reclamation is: to divide the usar land into small fields, to erect small fields—embankments around all them to hold water, and then frequent ploughing. This process will cause sufficient leaching of the salts down to greater depths resulting in the improvement of soil structure.


Diagnosis and Improvement of Saline and Alkali Soils, U.S. Salinity Laboratory Staff, Agricultural Handbook, No. 60, U.S. Dept. of Agriculture, 1954.
The bulky organic and green manures improve permeability and structure of the usar soil, producing various organic acids which neutralize some of the harmful salts. After application of well-powdered gypsum to the soil, water is allowed to stand for the completion of its reaction. The green manure crops like dhaincha, sensi and indigo should be grown, and after about one and a half months, the green crop should be applied as manure to the land, thus the crop of paddy may be usefully grown. The other crops of the kharif and rabi seasons may also be produced; and the green manuring is thus the best for making such soils profitable.

1. Khan, A.D. Diagnosis and Reclamation of Usar Soils, Bulletin No.4, (Lucknow, 1951), p.11.
CHAPTER IV

IRRIGATION

The districts of Budaun and Shahjahanpur have appreciable irrigation facilities although the percentage of irrigated land to the total cultivated area shows considerable variations. Fig. 36 shows that in the east of the district of Budaun the percentage of the irrigated area to the total cultivated land goes down to 5, while in the same district in the northeastern part it goes up to 40. Fig. 36 further shows that with the exception of four parganas lying in the district of Budaun and five parganas in the extreme southeast, the entire area under study has less than 25 per cent irrigated area to the cultivated area.

A comparison of Figs. 35 and 36 would show that the high percentage of irrigated area in these parganas is either due to the large number of tube-wells or the presence of canals.

No irrigation map of the districts is available. At best the maps prepared by the State-Tube-Well and Canal Irrigation Departments show the location of tube-wells and canals in the different areas.

The construction of wells in banerar land is a common feature, while in the khader and tarai lands the subsoil remains almost saturated owing to nearness of the underground water and irrigation to the crops is not generally required.

1. The location of masonry wells and private tube-wells, owing to their private management, is not shown on the irrigation map of the Irrigation Department and therefore they are not located in Fig. 35. In addition to canal and tube-wells, there are other sources of irrigation, e.g., rahat, cheras, dhekli, drawing water from masonry and non-masonry wells, ponds or streams. In assessing the proportion of irrigated area to the total cultivated area, all sources of irrigation have been considered.
Fig. 35 shows the distribution of State tube-wells and the system of canals in the area. The Irrigation Department has divided the districts into various irrigation groups for purposes of administrative conveniences. It will be seen from Fig. 35 that there is a heavy concentration of tube-wells in the Bisauli group, in the eastern half of Islamnagar and Sahaswan groups and in the central parts of Budaun and Kakrala groups. There is a complete absence of tube-wells in the western parts of these groups owing to the presence of either bhur soil or khadar soils, the former being mostly barren and the latter having the relative nearness of the subsoil water. But in these groups, there are also loamy or sandy loam areas which are lacking in irrigation facilities, particularly by tube-well. With the exception of Pawayan tahsil (east and west) and the Jalalabad tahsil, almost the whole of the district of Shahjahanpur is irrigated by canals.

Table III shows that with the exception of four parganas—two in the northwest and two in the southeast—where no facility for tube-well irrigation exists, the rest of the district of Shahjahanpur has all the sources of irrigation available in the area; but the northwest part of Shahjahanpur district—Khera Bajhera, Tilhar and Nigohi—has little irrigation by tube-wells. In the Budaun district tube-wells and masonry wells are the main sources of irrigation.

Fig. 36 shows the percentage of irrigated land to the total cultivated area in each pargana. It will be seen from Fig. 36 that the whole of the districts of Budaun and Shahjahanpur, with the exception of four parganas—two in the east of Budaun and two in the northwest and east of Shahjahanpur
district—have irrigated area above 15 per cent while the high percentage of irrigated lands shows a close correlation with the existing available facilities of irrigation from tube-wells or canals (Figs. 35 and 36).

Lakes and ponds also constitute a significant source of irrigation in the districts. The lakes and ponds have been divided into two categories based on their size and capacity for irrigation: large lakes and ponds which can irrigate more than 100 acres and small lakes and ponds which irrigate less than 100 acres. The large lakes and ponds are found generally towards the right bank of the river Ramganga and indicate that the river flowed a little to the west in the past. The smaller lakes and ponds are, however, well utilized and irrigate sizeable area in the south-western, southeastern and northeastern parts of Budaun district, and the southwestern and eastern parts of Shahjahanpur district.

The other source of irrigation is the streams which have largest irrigation in the southeast of Budaun and southwest of Shahjahanpur districts—Usahat and Jalalabad, in the latter this is the largest source of irrigation (Table III).

The total area irrigated and its percentage to the total cultivated land has been given in the Table III. The total area irrigated by all means in the two districts is 422,525 acres which is 22.9 per cent of the total cultivated land.  

1. The total cultivated land includes the net cropped land and the current fallow land in the year 1962-63.
Irrigation by State Tube-Wells

The area irrigated by State tube-wells have been divided into 10 groups for administrative convenience. The whole Gunnaur tahsil in Budaun and Tilhar tahsil in Shahjahanpur districts are, however, devoid of State tube-wells; besides it, pargana Jamaur also has no State tube-well.

It will be seen from table IV that Bisauli group possesses the largest number of these tube-wells, being 131. It has the largest cultivable as well as irrigated areas under their command. This area consists of good loamy soil. The Budaun group ranks second in importance, both in the number of tube-wells, irrigated area and the culturable commanded area, which consists of both loamy and sandy loam soils. The Sahaswan group, mostly sandy loam area, has the third largest number of these wells as well as the irrigated and the culturable commanded areas. The groups of Islamnagar, Kakrala, Dataganj, Jalalabad, Pawayan west and Pawayan east have considerable numbers of tube-wells and the cultivable area under their command is fairly big. The depth of subsoil water in the bangar land of the whole area ranges from about 3 to 12 metres so that the construction of tube-wells is easy. The cultivable area commanded by tube-wells varies from one group to another in accordance with varying rainfall during the year, the soil characteristics, the cropping pattern and the different crops with varying irrigation needs.

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1. A group of State tube-wells may be comprising more than one pargana, as in Bisauli or Sahaswan groups.
<table>
<thead>
<tr>
<th>Tube-well Groups</th>
<th>Total No.</th>
<th>Total Culturable</th>
<th>Total Area irrigated by State Tube-wells</th>
<th>Irrigated area of only sugarcane (acres)</th>
<th>Seasonal average consumption of water per acre (litres)</th>
<th>Total assessment from tube-well irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(C.C.A.)</td>
<td>(acres)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bisauli (Bisauli and Satasi parganas)</td>
<td>131</td>
<td>117,309</td>
<td>7,297</td>
<td>27,245</td>
<td>6,137</td>
<td>4,305</td>
</tr>
<tr>
<td>Islamnagar</td>
<td>30</td>
<td>24,000</td>
<td>1,349</td>
<td>5,334</td>
<td>1,095</td>
<td>615</td>
</tr>
<tr>
<td>Sahaswan (Sahaswan and Kot parganas)</td>
<td>107</td>
<td>85,600</td>
<td>3,939</td>
<td>20,559</td>
<td>2,761</td>
<td>1,904</td>
</tr>
<tr>
<td>Budaun (Budaun and Ujhani parganas)</td>
<td>129</td>
<td>106,050</td>
<td>5,117</td>
<td>27,514</td>
<td>2,946</td>
<td>3,104</td>
</tr>
<tr>
<td>Dataganj (pargana Salmpur)</td>
<td>20</td>
<td>4,649</td>
<td>476</td>
<td>2,287</td>
<td>186</td>
<td>114</td>
</tr>
<tr>
<td>Kakrala (pargana Ujhani)</td>
<td>43</td>
<td>30,600</td>
<td>1,811</td>
<td>8,778</td>
<td>1,596</td>
<td>1,273</td>
</tr>
<tr>
<td>Jalalabad</td>
<td>19</td>
<td>5,788</td>
<td>426</td>
<td>5,208</td>
<td>170</td>
<td>201</td>
</tr>
<tr>
<td>Shahjahanpur (parganas Kant and Shahjahanpur)</td>
<td>6</td>
<td>4,868</td>
<td>195</td>
<td>974</td>
<td>149</td>
<td>90</td>
</tr>
<tr>
<td>Pawayan West (parganas Pawayan and Baragaon)</td>
<td>60</td>
<td>52,222</td>
<td>6,107</td>
<td>6,343</td>
<td>5,556</td>
<td>995</td>
</tr>
<tr>
<td>Pawayan East (pargana Khutar)</td>
<td>25</td>
<td>20,420</td>
<td>1,345</td>
<td>1,463</td>
<td>1,287</td>
<td>187</td>
</tr>
</tbody>
</table>

Source: Unpublished Records of State Tube-wells Irrigation Department, Budaun and Shahjahanpur.
Table IV further shows that the sugarcane is the chief irrigated crop in the kharif season in all groups of State tube-wells except Dataganj and Jalalabad groups where cultivation of sugarcane is small due to clayey texture of soil and mostly water-logged conditions in Dataganj, and in Jalalabad due to sandy texture of soil, high level of subsoil water and the waterlogging.

Besides the rabi crops, sugarcane is also irrigated in rabi considerably, particularly in Bisauli, Budan, Sahaswan and Kakrala groups.

During the year 1962-63 the largest tube-well irrigation revenue was realised from the Bisauli group, followed by Budan, Sahaswan, Pawayan west and Kakrala, and the ranking is in direct proportion to number of tube-wells. The larger the number of tube-wells, the greater is the amount of revenue realised.

Owing to volumetric sale of water in tube-well irrigation, the cultivator is financially interested in reducing the wastage of water between the well and the fields. A secondary thing is that when water for drinking, food preparing and bathing purposes is required by the peasants, it is healthy and free from germs of diseases.¹

To meet the irrigation demands the flow of water in the subsoil must be adequate and should not be inactive during a possible draught period of acute irrigation demands.

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The average discharge with a 15.24 cm-strainer (or 6") is about 1,40,900 litres per hour by a State Tube-Wall. The maximum area irrigable by a tube-well, however, depends on the time available between the waterings which again varies with the weather conditions, the nature of soils and the crops to be irrigated.

Under full raabi demand a tube-well, if operated for 22 hours a day, can irrigate about 330 acres of the cropped land during 45 days of irrigation in the raabi (15 November to 31 December or 1 December to 15 January) because a tube well irrigates an acre in 5 hours on an average. Gram, peas and barley need one watering during the early growing period, while wheat crop on loamy or sandy loam soil requires one watering in 40 days, usually from 15 November to 31 December in Budaun district and from 1st December to 15 January in Shahjahanpur district.

Sugarcane, an annual crop, requires irrigation from 15 March to 15 June and in October and occasionally in November. It is usually irrigated four or five times. A tube-well, therefore, can provide water to 145 acres of sugarcane on an average.

Table V shows that the cost of irrigation by a State tube-well is charged after assessment on metric values of supply of water, irrespective of crops, season and soil-types. Likewise irrigation by private tube-wells is generally provided on the basis of per hour supply.
It will be seen from Table V that irrigation from ponds and streams is the cheaper and tube-well irrigation is costliest but in view of the seasonal nature of ponds and streams, irrigation from these sources cannot be relied upon. Further the quantity of water available from these sources is inadequate to meet the needs of sugarcane.

Although masonry wells constitute a better source of irrigation as compared to ponds and cheaper in relation to tube-wells, the access to tube-well irrigation saves the cultivator from the initial expenditure in digging the wells and as the cultivators are not well off, they would prefer a relatively expensive source of irrigation which does not involve any initial expenditure and assures a regulated and adequate supply of water on demand.

1. The charges of irrigation by State tube-well are reduced to 53 per cent of the total if and when the following crops are irrigated: rice, maize, cotton, sannhemp, fodder, dhaingha, and moong (green gram pulse).
In the tract of sandy or sandy loam soil tube-well proves more profitable than masonry well as the former can irrigate much larger area than the latter. This is mainly because irrigation in sandy loam needs a larger quantity of water which can be well provided by tube-wells. But where tube-well water is not available, the masonry well with *rabat* (Persian wheel) is largely used, for instance, in the southwestern half of Sahaswan tahsil, where there are few tube wells, the area is irrigated by masonry wells. It is interesting to note that out of a total irrigated area of 64,664 acres in Sahaswan tahsil (pargana Kot and Sahaswan), the tube-wells irrigate 24,496 acres—about 38 per cent of the irrigated area, while out of total irrigated area, 32,454 acres in pargana Sahaswan the tube-wells irrigate 5,554 acres,—about 17 per cent only. The main reason of the sharp decline of tube well irrigation in this pargana is due to the predominance of sandy soils.

The cost of irrigation by tube-well to the various crops (Table V) varies from rupees 9 to 16 per acre. This variation is in accordance with the varying volume of water needed by different crops. For example, an acre of sugarcane may require three or four times more water than that required by wheat, gram, barley or peas in an acre.

**Canal Irrigation:**

Canal irrigation is confined only in the district of Shahjahanpur. The area is not, however, exclusively irrigated by canals. Table III shows that the area irrigated by the Sarda Canal system in Shahjahanpur district varies from 25 per cent to 96 per cent of the total irrigated land.
Canal irrigation started in the area since 1928. Before the inception of canals in this area, ponds and wells constituted the main sources of irrigation. Canal irrigation has been gradually increasing in this area so much so that in 1962-63 the total irrigated area by canals rose to 122,304 acres—66 per cent of total irrigated area or 16 per cent of the total cultivated area. The percentage of canal irrigation is largest in the central parts of the Shahjahanpur district (parganas Tilhar, Jalalpur, Nigah, Katra, Kant, Jamsur and Shahjahanpur). It constitutes 87 to 96 per cent of the total irrigated area. Canal irrigation is least in the southwest and in the eastern portions of Shahjahanpur district (parganas Jalalabad, Fawyn and Khutur) being 25 to 47 per cent of the total irrigated area.

The total culturable area commanded by canal system in the district is 459,228 acres, out of which 147,851 acres or 54 per cent of the culturable commanded area are at present irrigable by the canal system. But the actual area irrigated by canals in the kharif season is 75,654 acres or 40 per cent of the total area irrigated by all sources, and 48,702 acres or 28 per cent in the rabi season, totalling to 122, 304 acres or 66 per cent of the total irrigated area in the year of inquiry, Table VI.

The branches of the Sarda Canal system provide water to their distributaries which further feed the minor canals. Canal water is received up to outlet known as kulaha, from where it is distributed to fields through small channels known as guls. The guls which are privately constructed...
### TABLE VI

Area Irrigated by Canals, District Shahjahanpur, 1962-63

(in acres)

<table>
<thead>
<tr>
<th>Gross area commanded by canals</th>
<th>Culturable area commanded by canal irrigation works</th>
<th>Area irrigable at present by canal irrigation works</th>
<th>Area irrigated by canals, 1962-63</th>
<th>The crop year in which maximum area of the district was irrigated by canals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Kharif season</strong></td>
<td><strong>Rabi season</strong></td>
<td><strong>Total</strong></td>
<td><strong>Year</strong></td>
<td><strong>Area</strong></td>
</tr>
<tr>
<td>699,739</td>
<td>439,228</td>
<td>147,831</td>
<td>75,634</td>
<td>48,670</td>
</tr>
</tbody>
</table>

Percentage of area irrigated by canals to the total irrigated area

<table>
<thead>
<tr>
<th></th>
<th>40%</th>
<th>26%</th>
<th>66%</th>
</tr>
</thead>
</table>

Seasonal percentage of canal irrigation

<table>
<thead>
<tr>
<th></th>
<th>60%</th>
<th>40%</th>
</tr>
</thead>
</table>

Source: Canal Irrigation Records (unpublished), Canal Irrigation Department, Shahjahanpur.
by farmers get silted sometimes and result in much wastage of water due to improper maintenance. The kulabas, which are generally under the charge of the Irrigation Department of the district, are not at times properly looked after and result in uneconomic use of water by the farmers.

Large variations occur in the supply of water in the river Sarda and in consequence the discharge of water into the branches, distributaries and minor canals also varies. There are variations also in the demand for irrigation from time to time during the kharif and rabi seasons. The discharge-run of water into irrigation channels varies widely from week to week, mostly in the rabi season; but the supply of water remains almost sufficient to rabi crops.

The total gross area commanded by canal irrigation system, as shown in the Table VI, is 699,739 acres in Shahjahanpur district. But the culturable area commanded by canals is 459,226 acres, a little over 60 per cent, out of which the area irrigable at present is 147,831 acres about one-third of the culturable commanded area.

The total area irrigated by canal-works, however, is much less than the irrigable area. The canal-irrigated area is 122,504 acres, a little over one quarter of the canal's culturable commanded area or about 33 per cent of the presently irrigable land.
It will be seen from Table VI that 60 per cent of the total irrigated land from canals in the Shahjahanpur district has been irrigated in the kharif season and 40 per cent in the rabi season, 1962-63. The increase of irrigated area in the kharif season is due to great demand for sugarcane and rice crops; this is further due to shortage of rainfall in June at Jalalabad, Pewayan, Khutar and Tilhar, in July at Shahjahanpur, Tilhar, Jalalabad and Pewayan, in August at Shahjahanpur and Khutar as given in the Table VII.

The comparisons of the areas under cultivation, irrigation, canal-irrigation, other types of irrigation, and crops in the years 1938-39, 1950-51 and 1962-63 have been given in the Table VIII.

The table shows a decrease of 9.4 per cent of canal irrigated area in 1950-51 as compared to the year 1938-39. But the area has increased to 34.2 per cent in 1962-63 as compared to 1950-51. Irrigation from wells has progressively increased since 1950-51 but there is a steady decrease in the irrigated area from ponds.

The Sarda Canal system in Shahjahanpur district has its five main branch canals, thirteen distributary canals and numerous minor canals. Their lengths in Shahjahanpur district, the bed-width and depth of water of each of them are given in the Table IX. The Shahjahanpur branch, alongwith its distributaries, possesses the largest area of the district in its command. This and the third largest branch, namely Nigohi branch, finish their work within the district, while Hardoi branch and Khutar and Kheri branches go to the Lakhimpur district.
<table>
<thead>
<tr>
<th>Stations</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>December</th>
<th>January</th>
<th>February</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Actual rainfall</td>
<td>Average</td>
<td>Actual rainfall</td>
<td>Average</td>
<td>Actual rainfall</td>
</tr>
<tr>
<td>Datganj</td>
<td>76.7</td>
<td>19.1</td>
<td>287.0</td>
<td>168.0</td>
<td>7.4</td>
<td>nil</td>
</tr>
<tr>
<td>Jalalabad</td>
<td>82.6</td>
<td>39.4</td>
<td>259.2</td>
<td>151.2</td>
<td>5.3</td>
<td>nil</td>
</tr>
<tr>
<td>Tilhar</td>
<td>94.7</td>
<td>nil</td>
<td>302.9</td>
<td>127.0</td>
<td>7.8</td>
<td>nil</td>
</tr>
<tr>
<td>Shahjahanpur</td>
<td></td>
<td></td>
<td>306.1</td>
<td>261.2</td>
<td>294.3</td>
<td>167.7</td>
</tr>
<tr>
<td>Payyan</td>
<td>139.3</td>
<td>129.8</td>
<td>350.9</td>
<td>202.0</td>
<td>7.4</td>
<td>nil</td>
</tr>
<tr>
<td>Khutar</td>
<td>138.9</td>
<td>124.2</td>
<td></td>
<td>303.4</td>
<td>nil</td>
<td>6.5</td>
</tr>
</tbody>
</table>
### TABLE VIII

Comparison of Cultivated and Irrigated Areas and of Crops, district Shahjahampur. (in acres)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>755,713</td>
<td>791,946</td>
<td>960,504</td>
</tr>
<tr>
<td>Total cultivated land</td>
<td>+ 7.9</td>
<td>+ 21.3</td>
<td></td>
</tr>
<tr>
<td>Total irrigated area</td>
<td>175,608</td>
<td>144,297</td>
<td>184,622</td>
</tr>
<tr>
<td>Area irrigated by canals</td>
<td>100,557</td>
<td>91,130</td>
<td>122,504</td>
</tr>
<tr>
<td>Area irrigated by wells (of all types)</td>
<td>54,332</td>
<td>20,246</td>
<td>37,642</td>
</tr>
<tr>
<td>Area irrigated by ponds and other sources</td>
<td>32,921</td>
<td>167,111</td>
<td>128,996</td>
</tr>
<tr>
<td>Double cropped area</td>
<td>96,282</td>
<td>97,765</td>
<td>128,996</td>
</tr>
<tr>
<td>Area under rice crop</td>
<td>120,068</td>
<td>167,111</td>
<td>200,690</td>
</tr>
<tr>
<td>Area under wheat crop</td>
<td>258,906</td>
<td>216,182</td>
<td>128,406</td>
</tr>
<tr>
<td>Total area under millets, gram and barley</td>
<td>267,051</td>
<td>268,861</td>
<td>365,572</td>
</tr>
<tr>
<td>Area under sugarcane</td>
<td>52,449</td>
<td>65,572</td>
<td>75,206</td>
</tr>
<tr>
<td>Area under poppy</td>
<td>1,529</td>
<td>2,951</td>
<td>negligible</td>
</tr>
<tr>
<td>net increase or decrease of area to the year 1958-39 (per cent)</td>
<td>-17.2</td>
<td>+ 28.1</td>
<td>-16.8</td>
</tr>
<tr>
<td>net increase or decrease of area to the year 1950-51 (per cent)</td>
<td>-9.4</td>
<td>+ 0.7</td>
<td>-0.5</td>
</tr>
</tbody>
</table>

Source: (1) Season and Crop Reports, Department of Land Records, Uttar Pradesh Government, (2) Unpublished Records, Department of Land Records of Tahsils and the district.
### TABLE IX
Branches and Distributaries of Sarda Canal System, Shahjahanpur District, 1962-65

<table>
<thead>
<tr>
<th>Canals</th>
<th>Length (kms.)</th>
<th>Bedwidth (metres)</th>
<th>Depth of water (metres)</th>
<th>No. of days running</th>
<th>Average discharge, 1962-65 (cusecs per second)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Kharif</td>
<td>Rabi</td>
</tr>
<tr>
<td>Shahjahanpur Branch Canal:</td>
<td>67.6</td>
<td>13.71</td>
<td>1.52</td>
<td>182</td>
<td>114</td>
</tr>
<tr>
<td>Khudaganj distributary</td>
<td>65.565</td>
<td>5.49</td>
<td>1.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tilhar distributary</td>
<td>16.291</td>
<td>1.85</td>
<td>0.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Katra distributary</td>
<td>14.427</td>
<td>2.74</td>
<td>0.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gandhar distributary</td>
<td>24.744</td>
<td>2.74</td>
<td>0.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Madnapur distributary</td>
<td>22.932</td>
<td>4.57</td>
<td>1.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jalsalabad distributary</td>
<td>23.234</td>
<td>3.86</td>
<td>1.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kamalpur distributary</td>
<td>11.275</td>
<td>5.55</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nigahi Branch Canal:</td>
<td>16.327</td>
<td>10.56</td>
<td>1.52</td>
<td>129</td>
<td>102</td>
</tr>
<tr>
<td>Intgaon distributary</td>
<td>14.480</td>
<td>4.27</td>
<td>1.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Karali distributary</td>
<td>9.117</td>
<td>2.74</td>
<td>0.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beer distributary</td>
<td>17.096</td>
<td>2.74</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paima distributary</td>
<td>17.498</td>
<td>3.05</td>
<td>0.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardoi Branch canal:</td>
<td>50.447</td>
<td>10.38</td>
<td>1.52</td>
<td>123</td>
<td>96</td>
</tr>
<tr>
<td>Shahabad distributary</td>
<td>32.190</td>
<td>4.27</td>
<td>1.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosa distributary</td>
<td>24.140</td>
<td>2.74</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Khutar Branch Canal:</td>
<td>32.5</td>
<td>10.38</td>
<td>1.52</td>
<td>108</td>
<td>87</td>
</tr>
<tr>
<td>Kheri Branch Canal:</td>
<td>16.3</td>
<td>10.36</td>
<td>1.52</td>
<td>102</td>
<td>81</td>
</tr>
</tbody>
</table>

Source: Irrigation records (unpublished), Canal Irrigation Department, Shahjahanpur.
The Shahjahanpur branch, longest in the area, works with its 7 distributary-canals and numerous minor canals and drains in between Bahgul and Kanganga rivers, on one side, and the Garra river on the other. The bed of the branch is 13.71 metres wide, 1.52 metres deep and the branch is 67.6 kilometres long. Among its distributaries, the Khudaganj distributary is the biggest in length, bed-width and depth of water. The Gandhar, Jalalabad and Madnapur distributaries rank next in importance. The branch and the distributaries distribute the water supply to their numerous minor canals, of which nine are chief. The Shahjahanpur branch has been working for maximum period in the year 1962-63 for 182 kharif and 116 rabi days.

The Nigohi branch canal, 16.827 kilometres long, 10.36 metres wide and 1.52 metres deep, has been working for 251 days of the year, mostly in kharif season. Of its four distributaries, Paina is the largest, and Intgaon is broadest and deepest. It has many minor canals and numerous drains to support the supply of water, in which six minors are the main. The canal system of the Nigohi branch is limited to the area between Garra and Khanaut rivers in the district and north of Shahjahanpur city.

The total area irrigated exclusively by the minor canals of the Shahjahanpur Branch is 2,779 acres in the kharif and 3,580 acres in the rabi season, 1962-63; whereas the minor canals of the Nigohi branch irrigated 3,951 acres and 3,127 acres in the kharif and rabi seasons respectively.
The irrigation work of the branch, distributaries, minors and the drains of the Hardoi branch canal is between the Khannaut and the Gomati rivers. The Hardoi branch, second longest in the area, is 50.447 kilometres long, with a bed-width of 10.36 metres and depth of 1.52 metres. It worked for 219 days in the year 1962-63, (123 days in the kharif season). Of its two main distributaries, Shahabad and Rosa, the former is the larger in length, breadth and depth of the bed, Table IX. The Shahabad distributary goes to Lakhimpur district, while the Rosa distributary which originates from the former distributary, irrigates the area within the district Shahjahanpur. The area irrigated by the Hardoi branch, distributaries and minor canals in the year 1962-63 is 39,120 acres, or about 32 per cent of the total canal irrigated area.

The Khutar branch canal, 32.5 kilometres long, 10.36 metres wide and 1.52 metres deep, has been working for 195 days of the year, (103 days in the kharif season). It has no distributary or minor canals in the area. The canal is situated in the east of the Gomati river. It shares 1.7 per cent of the total canal irrigation in the district.

The kheri branch canal, 16.3 kilometres long, 10.36 metres wide and 1.52 metres deep, is the smallest branch canal in the area. It has one minor canal. These have been working for 102 days in the kharif season and 81 days in the rabi season. The canal is situated in the easternmost part of the area. The branch and the minor canals share the least proportion, 0.3 per cent, of the canal irrigation in the district. (Table X)
<table>
<thead>
<tr>
<th>Total lengths of canals</th>
<th>Total area irrigated (in acres)</th>
<th>Total area irrigated by all canals in the kharif and rabi seasons, 1962-63</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total length of all branch canals</td>
<td>Total irrigated by Nigchi branch, Hardoi Khutar, Kheri branch and minor canals</td>
<td></td>
</tr>
<tr>
<td>Total length of all distributaries and minor canals</td>
<td>Total irrigated by Kharif and Rabi season</td>
<td></td>
</tr>
<tr>
<td>183.674</td>
<td>58,745</td>
<td>73,634</td>
</tr>
<tr>
<td>290.369</td>
<td>22,055</td>
<td>48,670</td>
</tr>
<tr>
<td>178.260</td>
<td>39,120</td>
<td>122,304</td>
</tr>
<tr>
<td>652.923</td>
<td>2056</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>548</td>
<td></td>
</tr>
</tbody>
</table>

Percentage of the area irrigated by the canals to the total canal irrigated area:

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>48</td>
<td>18</td>
<td>32</td>
<td>1.7</td>
<td>0.3</td>
</tr>
</tbody>
</table>
The average discharge of water and the flow is different in the five branch canals. The discharge of water in the Shahjahanpur branch is, on an average, 469 cusecs in the kharif and 653 cusecs in the rabi season, being the largest in all canal irrigation system in the district Shahjahanpur. The discharge of water in the Nigohi branch has an average of 294 cusecs in the kharif and 264 cusecs in the rabi season. The average discharge of water in Hardoi branch is 378 cusecs in kharif and 288 cusecs in the rabi season, Table IX. The average discharge of water in the khutar branch is 246 cusecs in the kharif season and 229 cusecs in the rabi season; while the average discharge in the kheri branch is 253 and 217 cusecs in the kharif and rabi seasons respectively.

The direction of the flow of the five branch canals is generally north to south with a very slight moving; the distributaries have a little greater curvature or moving; while the directions of minors have much larger and different bending than other canals.

The total length of all canals—branches, distributaries and minors—in the area under review, is 652.923 kilometres, as is given in the Table X. The five branch canals have a total length of 183.674 kilometres; the thirteen distributary canals have a total length of 290.989 kilometres, while thirty seven minor canals of the canal-system have a total length of 178.260 kilometres in the area. The bigger number of minor canals with

1. The discharge of water, measured at the Canal Headworks, is still recorded in the cusecs (cubic feet per second).
a total length of 178,260 kilometres denotes their average length, being very small. There are numerous drains to help canal irrigation system.

The table further shows that the Shahjahanpur branch system of canals irrigates the largest share, 48 per cent of the total canal-irrigated area in the district. The Shahjahanpur branch system of canals irrigates 55,762 acres in Kharif season and 22,983 acres in the rabi season; the Nigohi branch system irrigates 13,664 acres in Kharif and 8,371 acres in rabi, being totally 18 per cent of the total canal irrigated area; while Hardoi branch system irrigates 22,926 acres in Kharif and 16,194 acres in the rabi season, being totally about 32 per cent of the total canal irrigated area. The Khutar branch irrigates 1,095 and 961 acres in the Kharif and rabi seasons respectively, which is only 1.7 per cent of the total canal-irrigated area of the district. The total area irrigated in the Kharif season by the entire canal system in the district is 73,634 acres or 60 per cent of total canal irrigation, nearly half of which is shared by the Shahjahanpur branch system. In the rabi season the total canal-irrigated area is 48,670 acres, being 40 per cent of canal irrigation in the district.

The total area irrigated by canal system in the year 1962-63 is 122,304 acres in the district which is 66 per cent of the total land irrigated by all means (Table III), 13 per cent of the total cultivated land, and 11 per cent of the total area of the district.
There are two means of canal irrigation: flow and lift. \(^1\) Wherever the field to be irrigated can well be irrigated by the flow of water running in a canal or drain through breaking the sided embankment of the canal or drain, the water of the canal is then allowed to come into the field freely, it is called the flow method of canal irrigation. In this method, the surface of the canal water must be higher than the level of the land to be irrigated to ensure the flow. In the other method, that is the lift method, the cultivator has some difficulties of employing labour for irrigation.

Wherever the surface of the land to be irrigated is higher than the water surface of the canal, the cultivator lifts the water through the bokey as it is called locally. \(^2\) The cultivator has to bear labour-charges for it. It is why the Irrigation Department has granted concessions by 50 per cent of what the charges are levied in the flow method. The water is also lifted with the leather-bucket, but only occasionally.

The flow method is most prevalent in the area and a low percentage of canal irrigation is by lift method. The Table III reveals that the largest percentage of canal irrigated land is irrigated by flow method in each of the parganas of Shahjahanpur district. The total canal irrigated area by flow methods is 109,928 acres being about 90 per cent and by the lift method 12,376 acres or about 10 per cent of the canal irrigation in the whole of the district.

---

1. Locally known as 'tor' and 'dal' respectively; the dal or lift method involves labour charges and, therefore, its rates of irrigation are half of the tor or flow method for all crops, Table XI.
2. A bokey is a rectangular basket made of bamboo plies, it is used with the help of four ropes tied on its corners; the water is lifted by two or four adults. The labourers are employed generally for a large irrigation.
The Rates:

The various crops are assessed at different rates of irrigation. The prevailing water rates/determined in accordance with water requirement of the crop and the method that has been applied for irrigation from canal. The Table XI shows the water rates in the following.

TABLE XI
CANAL IRRIGATION RATES, 1962-63

<table>
<thead>
<tr>
<th>Crops</th>
<th>Rate of irrigation per acre</th>
<th>By flow method</th>
<th>By 'lift' method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rupees</td>
<td>Paise</td>
<td>Rupees</td>
</tr>
<tr>
<td>Kharif Crops:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugarcane</td>
<td>32</td>
<td>00</td>
<td>16</td>
</tr>
<tr>
<td>Tobacco</td>
<td>16</td>
<td>00</td>
<td>8</td>
</tr>
<tr>
<td>Rice, vegetables, groves, orchards, water caltrop, melons, water-melons</td>
<td>00</td>
<td>7</td>
<td>00</td>
</tr>
<tr>
<td>Big millet (Jowar), bulrush, millet (Baira) and maize</td>
<td>7</td>
<td>00</td>
<td>3</td>
</tr>
<tr>
<td>Cotton (Palewa) 1</td>
<td>4</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>Fodder</td>
<td>3</td>
<td>00</td>
<td>1</td>
</tr>
<tr>
<td>Sannhemp (for green manuring)</td>
<td>2</td>
<td>00</td>
<td>1</td>
</tr>
<tr>
<td>Rabi Crops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td>14</td>
<td>00</td>
<td>7</td>
</tr>
<tr>
<td>Wheat, wheatgram, wheat-gram-peas</td>
<td>12</td>
<td>00</td>
<td>6</td>
</tr>
<tr>
<td>Peas, lentil, oilseeds</td>
<td>9</td>
<td>00</td>
<td>4</td>
</tr>
<tr>
<td>Palewa</td>
<td>3</td>
<td>75</td>
<td>1</td>
</tr>
<tr>
<td>Fodder</td>
<td>3</td>
<td>00</td>
<td>1</td>
</tr>
</tbody>
</table>

1. The application of the pre-sowing irrigation is locally termed as Palewa.
The crop of sugarcane has largest requirement of water, hence it is assessed at the rate of rupees 52 and rupees 16 per acre by flow and the lift methods respectively; while wheat, alone or mixed with gram or peas or both, is assessed at the rate of rupees 12 and 6 per acre, because of the lesser water requirement of these crops. In case the crops are adversely affected by climatic vagaries like hailstorms, floods or droughts, the whole or part of the irrigation dues is remitted.

The canal irrigation rates for rice and vegetables are rupees 14 and 7 by flow and lift methods respectively. The crops of millets and maize require lesser water than the above crops and the irrigation rates of them are just half to that of rice-irrigation. For crops of peas, lentil and oilseeds the respective rates are rupees 9 and 4.50 per acre. The smallest rates are of fodder and sannhemp crop for green manuring.

Irrigation by Masonry and Non-masonry Wells, Streams, Lakes & Ponds

The areas bordered by the river Ramganga, and nearly the whole of Shahjahanpur district possess the largest number of non-masonry wells, while the district of Budaun has the largest number of masonry wells.

It will be seen from Table XII that there are about 159 masonry wells which lie within the canal irrigation zone mostly in the western half of Shahjahanpur district while the non-masonry wells within the canal irrigation zone are numerous in the southern half of Shahjahanpur district. In the whole
### TABLE XII
MASONRY AND NON-MASONRY WELLS, PONDS, AND LAKES, BUDAUN AND SHAHJAHANPUR DISTRICTS 1962-63

<table>
<thead>
<tr>
<th>PARGANAS</th>
<th>Number of wells used in 1962-63</th>
<th>irrigation zone</th>
<th>out of canal irrigation zone</th>
<th>within canal irrigation zone</th>
<th>Number of masonry wells</th>
<th>Number of non-masonry wells</th>
<th>Number of ponds and lakes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUDAUN</td>
<td></td>
<td>State Govt.</td>
<td>Private</td>
<td>Total</td>
<td>196-63 masonry</td>
<td>196-63 non-masonry</td>
<td>196-63 Pond and Lake</td>
</tr>
<tr>
<td>Majarpur</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asnapur</td>
<td>1</td>
<td>2309</td>
<td>444</td>
<td>2310</td>
<td>431</td>
<td>444</td>
<td>119</td>
</tr>
<tr>
<td>Sahaswan</td>
<td>19</td>
<td>2862</td>
<td>1228</td>
<td>2865</td>
<td>1228</td>
<td>2865</td>
<td>119</td>
</tr>
<tr>
<td>Bet</td>
<td>85</td>
<td>1762</td>
<td>117</td>
<td>1854</td>
<td>169</td>
<td>1854</td>
<td>162</td>
</tr>
<tr>
<td>Islamnagar</td>
<td>74</td>
<td>2032</td>
<td>61</td>
<td>2106</td>
<td>61</td>
<td>2106</td>
<td>422</td>
</tr>
<tr>
<td>Bismal</td>
<td>88</td>
<td>899</td>
<td>143</td>
<td>1007</td>
<td>143</td>
<td>1007</td>
<td>452</td>
</tr>
<tr>
<td>Sisri</td>
<td>47</td>
<td>176</td>
<td>98</td>
<td>274</td>
<td>84</td>
<td>272</td>
<td>136</td>
</tr>
<tr>
<td>Budum</td>
<td>82</td>
<td>715</td>
<td>152</td>
<td>767</td>
<td>3</td>
<td>760</td>
<td>136</td>
</tr>
<tr>
<td>Ujhan</td>
<td>52</td>
<td>1039</td>
<td>69</td>
<td>1108</td>
<td>7</td>
<td>1102</td>
<td>204</td>
</tr>
<tr>
<td>Salempur</td>
<td>10</td>
<td>409</td>
<td>152</td>
<td>561</td>
<td>3</td>
<td>558</td>
<td>102</td>
</tr>
<tr>
<td>Hastat</td>
<td>40</td>
<td>585</td>
<td>152</td>
<td>737</td>
<td>2</td>
<td>735</td>
<td>72</td>
</tr>
</tbody>
</table>

| District Total | - | 478 | 14188 | 5974 | 14646 | 5874 | 14646 | 5874 | 14 | 1135 | 8 | 2889 | 127 | 35 | 1897 |

<table>
<thead>
<tr>
<th>SHAHJAHANPUR</th>
<th>Number of wells used in 1962-63</th>
<th>irrigation zone</th>
<th>out of canal irrigation zone</th>
<th>within canal irrigation zone</th>
<th>Number of masonry wells</th>
<th>Number of non-masonry wells</th>
<th>Number of ponds and lakes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khara Bajhera</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Talhar</td>
<td>48</td>
<td>1444</td>
<td>26</td>
<td>1444</td>
<td>26</td>
<td>1444</td>
<td>76</td>
</tr>
<tr>
<td>Jalalpur</td>
<td>-</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Khojhi</td>
<td>2</td>
<td>19</td>
<td>19</td>
<td>38</td>
<td>13</td>
<td>52</td>
<td>4</td>
</tr>
<tr>
<td>Katra</td>
<td>-</td>
<td>59</td>
<td>59</td>
<td>59</td>
<td>59</td>
<td>59</td>
<td>5</td>
</tr>
<tr>
<td>Jalalabad</td>
<td>22</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>Kent</td>
<td>2</td>
<td>196</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Jumar</td>
<td>52</td>
<td>182</td>
<td>76</td>
<td>182</td>
<td>76</td>
<td>182</td>
<td>182</td>
</tr>
<tr>
<td>Shahjahanpur</td>
<td>15</td>
<td>80</td>
<td>189</td>
<td>209</td>
<td>189</td>
<td>209</td>
<td>189</td>
</tr>
<tr>
<td>Baramgan</td>
<td>4</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Fawiyen</td>
<td>7</td>
<td>1</td>
<td>55</td>
<td>55</td>
<td>55</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Khatar</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

| District Total | 159 | 666 | 1230 | 10899 | 1235 | 10899 | 1594 | 11565 | 1 | 95 | 145 | 583 | 35 | 29 | 5741 |

| Grand Total of the whole area | 159 | 666 | 483 | 15398 | 16775 | 15881 | 16775 | 16040 | 17493 | 15 | 1230 | 153 | 3472 | 162 | 64 | 7638 |

Source: Unpublished Records of Revenue Department, district Budaun and Shahjahanpur.
of Shahjahanpur district, there are 11,565 non-masonry wells in number out of which 666 are within the canal irrigation zone. The masonry wells are predominant in the western part of the area. Comparatively they are very smaller in number in Shahjahanpur district (1,394) than in Budaun district (14,646).

A masonry well involves the construction of long feeding channels in order to bring the water to the fields and this leads to some loss of water from absorption and evaporation; while a non-masonry well being much less expensive in construction can be dug quickly in close proximity to the crop and can supply water. During the year 1962-63, the eastern part of Budaun district and the whole of Shahjahanpur district possessed larger number of non-masonry wells (13,124) than the masonry wells (2,218). It is due to sudden need of irrigation in the kharif and mostly in the rabi season when the rainfall in the kharif was below the seasonal average (Table VII) and it was quite scanty in the rabi season.

The new wells constructed during the year of investigation have mostly been built in Budaun district. The masonry wells built by the State Government are 15, of which 14 are in Budaun district. Out of 1230 masonry wells built privately in the area, 1135 are in Budaun district due to more want of irrigation facilities. They are largest in the southwest and west of Budaun district (Sahaswan, Rajpura and Islamnagar parganas). The tract of least rainfall and mostly/or sandy loam soil—the western half of Budaun district—(Rajpura, Asadpur, Sahaswan, Kot and Islamnagar parganas)---has been paid due attention with the result of largest number of newly constructed masonry wells.
The irrigation by râkat or Persian wheels on a masonry well or by charaç or dhakli means of a well—masonry or non-masonry—is generally done on the daily wage basis; most of the cultivators do the work themselves, particularly when they irrigate from a non-masonry well.

There is a number of masonry and non-masonry wells which were not used during the year of investigation. These were 153 of the State property and 3,472 were private masonry wells, out of which 2,889 were in the Budaun district. The biggest number of total wells unused was 481 at Bisauli where the rainfall in the kharif season, 1962-63, was more than average.

There are 64 ponds and lakes in the area which are capable to irrigate above 100 acres each. The rivers like Ramganga, Bahgul, and Garra do a great deal to fill up large lakes and ponds in the wet monsoon months.

The ponds which can irrigate below 100 acres of land are large in number and are almost everywhere in the area. More than three fourth of all are in the district of Shahjahanpur. The western and the eastern parts of Budaun district have lesser number of such ponds than the middle part. The area irrigated by such ponds is larger in Budaun district (19,712 acres) than in the Shahjahanpur district (9,315 acres). In Shahjahanpur district they are mostly in the southern and eastern parts (Jalalabad, Kant, Jamaur, Shahjahanpur, Baragaon, Pawayan and Khutar), being 5,413 out of the district total 5,741. Greater utilization of this source of irrigation in Budaun than Shahjahanpur district is due to lesser average rainfall in the former district resulting in continuous need of irrigation.
The irrigation from a pond or stream is done through the bokey or lift system and the water is generally lifted to a height of 1 to 1.5 metres with two or three sets of labourers and bokeyas at different levels forming a terrace-like surface of the adjoining land.
CHAPTER V

Agricultural Land Use

Agriculture is the mainstay of most of the people in the area. The economy of the area is basically dependent on rural life. The cultivated area varies from 68.8 to 92.7 per cent of the total area. Fig. 37 shows that a substantial area remains unirrigated. Table XIII shows that the land under cultivation in the districts of Budaun and Shahjahanpur respectively is 85 per cent and 81 per cent of the total area, whereas the irrigated area in the respective districts varies from 7 to 40 per cent and 8 to 36 per cent of the total area under cultivation (Table III).

Table XIII shows the percentage of each use of land to the total area pargana-wise. Rajpura and Khutar parganas which cover the western and eastern parts of the area have lesser proportion, 69-70 per cent, of cultivated land as compared to the rest of the area. This is due to the fact that forests and meadows occupy very large areas here, 19 and 23 per cent of the total area as compared to other portions of the area. The northwestern part of Budaun district (parganas Kot, Islamnagar, Bisauli and Satasi) possesses more than 91 per cent of the total area under cultivation. The areas northeast and north of the river Ganga, west of the Jamganga and situated west of the Garra river have upto about 85 per cent of the total area under cultivation. At times some of fertile lands in the khadar is eroded or transformed into barren sandy land. A strong current of receding water is quite disastrous and causes great damage to the standing crops. Thus large tracts of land near the river courses of the Ganga
TABLE XIII

LAND UTILIZATION, BUDAUN & SHAHJAHANPUR DISTRICTS, 1962-63

Percentages to the total area of the parganas

<table>
<thead>
<tr>
<th>Parganas</th>
<th>Total area of the Pargana (acres)</th>
<th>Cultivated land %</th>
<th>Land under settle-groves &amp; roads</th>
<th>Land under water meadows &amp; bodies</th>
<th>Land Jungle cemetery &amp; crematory</th>
<th>Waste land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Majesty</td>
<td>104,113</td>
<td>68.8</td>
<td>2.8</td>
<td>4.9</td>
<td>18.5</td>
<td>4.6</td>
</tr>
<tr>
<td>Asadpur</td>
<td>127,025</td>
<td>77.0</td>
<td>2.9</td>
<td>6.4</td>
<td>6.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Sahaswan</td>
<td>180,319</td>
<td>83.3</td>
<td>2.6</td>
<td>4.8</td>
<td>5.4</td>
<td>2.7</td>
</tr>
<tr>
<td>Kot</td>
<td>90,492</td>
<td>92.7</td>
<td>3.3</td>
<td>1.6</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Islamnagar</td>
<td>86,519</td>
<td>91.7</td>
<td>3.7</td>
<td>1.6</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Bisauli</td>
<td>87,720</td>
<td>91.0</td>
<td>4.3</td>
<td>1.1</td>
<td>1.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Satasi</td>
<td>56,073</td>
<td>91.1</td>
<td>4.1</td>
<td>1.1</td>
<td>1.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Budaun</td>
<td>134,510</td>
<td>89.5</td>
<td>4.7</td>
<td>0.6</td>
<td>1.2</td>
<td>2.9</td>
</tr>
<tr>
<td>Ujhani</td>
<td>156,122</td>
<td>82.5</td>
<td>3.7</td>
<td>0.6</td>
<td>5.3</td>
<td>8.1</td>
</tr>
<tr>
<td>Salampur</td>
<td>146,811</td>
<td>77.5</td>
<td>3.4</td>
<td>0.9</td>
<td>5.3</td>
<td>8.1</td>
</tr>
<tr>
<td>Uschat</td>
<td>123,171</td>
<td>84.8</td>
<td>3.4</td>
<td>1.2</td>
<td>3.1</td>
<td>4.9</td>
</tr>
</tbody>
</table>

DISTRICT BUDAUN

<table>
<thead>
<tr>
<th>Parganas</th>
<th>Total area of the Pargana (acres)</th>
<th>Cultivated land %</th>
<th>Land under settle-groves &amp; roads</th>
<th>Land under water meadows &amp; bodies</th>
<th>Land Jungle cemetery &amp; crematory</th>
<th>Waste land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shera Bajhera</td>
<td>58,296</td>
<td>86.9</td>
<td>3.4</td>
<td>1.2</td>
<td>4.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Tilhar</td>
<td>79,761</td>
<td>87.7</td>
<td>4.4</td>
<td>2.4</td>
<td>3.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Jalalpur</td>
<td>47,311</td>
<td>83.9</td>
<td>3.9</td>
<td>2.1</td>
<td>5.4</td>
<td>2.7</td>
</tr>
<tr>
<td>Nigohi</td>
<td>71,293</td>
<td>85.3</td>
<td>3.9</td>
<td>2.1</td>
<td>3.3</td>
<td>4.1</td>
</tr>
<tr>
<td>Katra</td>
<td>8,279</td>
<td>83.1</td>
<td>7.3</td>
<td>2.6</td>
<td>3.9</td>
<td>1.3</td>
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<tr>
<td>Jalalabad</td>
<td>234,648</td>
<td>75.8</td>
<td>3.0</td>
<td>1.0</td>
<td>5.2</td>
<td>7.2</td>
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<tr>
<td>Kant</td>
<td>90,399</td>
<td>87.6</td>
<td>3.6</td>
<td>2.0</td>
<td>2.4</td>
<td>3.9</td>
</tr>
<tr>
<td>Jaimaur</td>
<td>64,572</td>
<td>77.8</td>
<td>3.5</td>
<td>1.0</td>
<td>4.0</td>
<td>10.7</td>
</tr>
<tr>
<td>Shahjahanpur</td>
<td>97,726</td>
<td>82.7</td>
<td>7.0</td>
<td>1.7</td>
<td>3.4</td>
<td>3.2</td>
</tr>
<tr>
<td>Baraon</td>
<td>52,260</td>
<td>86.3</td>
<td>3.9</td>
<td>2.3</td>
<td>4.2</td>
<td>1.9</td>
</tr>
<tr>
<td>Pawayan</td>
<td>197,755</td>
<td>84.5</td>
<td>3.9</td>
<td>2.8</td>
<td>2.7</td>
<td>5.7</td>
</tr>
<tr>
<td>Khutar</td>
<td>128,583</td>
<td>68.8</td>
<td>3.4</td>
<td>0.9</td>
<td>2.7</td>
<td>22.7</td>
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</tbody>
</table>

Total District Budaun: 1292,580

<table>
<thead>
<tr>
<th>Parganas</th>
<th>Total area of the Pargana (acres)</th>
<th>Cultivated land %</th>
<th>Land under settle-groves &amp; roads</th>
<th>Land under water meadows &amp; bodies</th>
<th>Land Jungle cemetery &amp; crematory</th>
<th>Waste land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shahjahanpur</td>
<td>1131,051</td>
<td>81.2</td>
<td>3.9</td>
<td>1.8</td>
<td>3.7</td>
<td>6.9</td>
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</tbody>
</table>

Total District Shahjahanpur: 1131,051

<table>
<thead>
<tr>
<th>Parganas</th>
<th>Total area of the Pargana (acres)</th>
<th>Cultivated land %</th>
<th>Land under settle-groves &amp; roads</th>
<th>Land under water meadows &amp; bodies</th>
<th>Land Jungle cemetery &amp; crematory</th>
<th>Waste land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total:</td>
<td>1292,580</td>
<td>83.1</td>
<td>3.5</td>
<td>0.9</td>
<td>3.8</td>
<td>5.7</td>
</tr>
</tbody>
</table>

Total District: Shahjahanpur 1131,051

Total District: 1292,580

Total District: 1131,051

Total District: 2423,630
and Ramganga have to be left uncultivated; this part of the land is also useful for the rural population, because it produces reed, locally known as 'sarwa' and 'beenda' and the thatching grasses known as 'poola', 'moonj' and 'kans'—which are used in thatched roofs in most of the rural houses.

The land occupied by settlement and roads is generally below 5 per cent everywhere except Katra and Shahjahanpur parganas (7.8 and 7 per cent). The proportion of land under groves nowhere exceeds 1.6 per cent of the total area in Budaukn district. However, in the parganas of Shahjahanpur district is as much as 3 per cent. The cemetery and crematory possess only 0.3 per cent or below everywhere. All parganas except Asadpur and Jalalabad, have less than 5 per cent waste land, while in the above two it is upto 8 per cent. Only 2.9 per cent of the area is the waste land in the whole district Budaukn while it is lesser in the Shahjahanpur district, being 2.4 per cent of the whole. In the non-agricultural area, the forests and meadows occupy the largest percentage (5.7 and 6.9) in the area under review. It is followed in ranking percentage by land under water bodies and then under settlements and roads.
Land Classification

The area has been divided into various types of usages. The non-agricultural uses of land have also been dealt with. An attempt has been made to classify the agricultural lands in accordance with their fertility and productivity.

The good quality land consists of areas under which are double cropping and sugarcane production. The medium quality land is cropped in either the kharif season or the rabi season and is left fallow in the other season. The land which is put to fallowing for one or two years is also included in this category of land.

It will be seen from Fig. 40 that the area under double cropping does not exceed 25 per cent to the total land under cultivation in the area. The table XIV shows that the good quality land varies from 12 to 41 per cent of the total area under cultivation. The area consisting of medium quality land varies from 59 to 88 per cent. The Table also reveals that 60 to 93 per cent of the total land under cultivation in the area remains unirrigated.

The good quality land possessing higher productive efficiency varies in the district of Budaun from 13 to 33 per cent of the total cultivated land while in the district of Shahjahanpur its proportion increases up to 41 per cent; it is due to better rainfall conditions, lesser variability of rainfall and greater sources and facilities of irrigation in the latter district than the former.
### Table XIV

Proportion of good quality and medium quality lands, and the unirrigated areas under cultivation, 1962-63

<table>
<thead>
<tr>
<th>Parganas</th>
<th>Percentage of unirrigated area to the total land under cultivation</th>
<th>Good quality land (acres)</th>
<th>Percentage to the total land under cultivation</th>
<th>Medium quality land: Percentage to the total land under cultivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ajnpura</td>
<td>78.0</td>
<td>22,004</td>
<td>22.5</td>
<td>67.5</td>
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<tr>
<td>sadpur</td>
<td>84.2</td>
<td>85,861</td>
<td>23.4</td>
<td>71.6</td>
</tr>
<tr>
<td>Sadaswan</td>
<td>77.0</td>
<td>27,060</td>
<td>19.2</td>
<td>80.8</td>
</tr>
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<td>At</td>
<td>60.3</td>
<td>25,022</td>
<td>30.9</td>
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<td>72.5</td>
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<td>Lisauli</td>
<td>60.0</td>
<td>16,327</td>
<td>21.4</td>
<td>78.6</td>
</tr>
<tr>
<td>Satasi</td>
<td>65.0</td>
<td>8,562</td>
<td>17.7</td>
<td>82.3</td>
</tr>
<tr>
<td>Sudaun</td>
<td>78.7</td>
<td>14,372</td>
<td>13.1</td>
<td>86.9</td>
</tr>
<tr>
<td>Uselahni</td>
<td>80.1</td>
<td>19,631</td>
<td>17.4</td>
<td>82.6</td>
</tr>
<tr>
<td>Sulempur</td>
<td>92.7</td>
<td>25,555</td>
<td>23.7</td>
<td>76.3</td>
</tr>
<tr>
<td>Uselah</td>
<td>95.0</td>
<td>18,961</td>
<td>19.8</td>
<td>80.2</td>
</tr>
</tbody>
</table>

### District Shahjahanpur

| Khola Bajhora  | 91.2 | 10,067 | 21.0 | 79.0 |
| Tilner         | 77.7 | 14,397 | 21.7 | 78.3 |
| Jalalpur       | 70.1 | 8,961  | 24.3 | 75.7 |
| Sigohi         | 69.0 | 13,895 | 24.5 | 75.5 |
| Jalra          | 74.7 | 1,444  | 22.5 | 77.5 |
| Jalalabad      | 75.7 | 28,325 | 17.3 | 82.7 |
| Ask          | 76.4 | 5,682  | 12.4 | 87.6 |
| Jamsar         | 74.4 | 13,485 | 23.9 | 70.1 |
| Shahjahanpur   | 76.5 | 14,441 | 19.7 | 80.3 |
| Haragaoon      | 64.4 | 16,974 | 41.0 | 59.0 |
| Faraway        | 80.0 | 48,386 | 31.6 | 68.4 |
| Knutar         | 91.7 | 27,257 | 34.8 | 65.2 |
IRRIGATION

The irrigation is done in both the kharif and rabi seasons. But in the kharif the greatest part of irrigation is shared by sugarcane, while the crop of transplanted rice may also be irrigated occasionally; 'its cultivation without irrigation is almost a gamble', however, it is grown without irrigation for the most part.

For the year as a whole, most of the irrigation is done in the rabi season, when much of the continual crop of sugarcane is also irrigated in addition to the rabi crops.

LAND UTILIZATION IN THE Kharif SEASON

The rainfall in the summer monsoon months, the kharif season, plays a very significant role in agriculture. If the rainfall is well distributed timely, all the kharif crops, with the exception of sugarcane, are grown well, mostly without irrigation.

It will be seen from Fig. 38 A that most of the cultivated areas in several parts of the two districts (Budaun and Shahjahanpur) have been cropped in the kharif season and the fallowing is confined to a small

FIG 38A

BUDAUN AND SHAHJAHANPUR DISTRICTS

CROP LAND USE
KHARIF SEASON
1962

Based on unpublished data of crops in the Kharif season 1962 in each of the parganas, obtained from the revenue departments of Budaun and Shahjahanpur districts.

Legend:
- Non agricultural lands
- Fallow land
- Non cereal crops
- Sugarcane
- Pulses
- Maize
- Rice (broadcast)
- Rice (transplanted)
- Millets and pulses
- Millets

Scale: 10 0 10 20 30 KILOMETRES
proportion of land in almost all the area under study. For instance, in Rajpura pargana, the net kharif cropped area is 60,597 acres or 89.6 per cent of the total land available for cultivation and the fallow land is 10.4 per cent. In Sahasvama pargana, the 95 per cent of the total land under cultivation was cropped in the kharif season, similarly 96.7 per cent in Bisaulti, 97 per cent in Khera Bajhera; Tilhar, Jalalpur, Katra , Nigohi and other parts of the area have the same condition.

The cereal crops of the kharif season are big millet, bulrush millet, pulses (pigeon pea, arhar) rice-transplanted, rice-broadcast, maize, small millet. The crops of millets are mostly grown mixed with the pulses (arhar). The non-cereal crops are sugarcane, groundnut, oilseeds, fodder crops, green-manure crops, cotton and vegetables.

Among the cereal crops, millets—grown alone or mixed with pulses (arhar)---occupy the largest areas in most of the parganas of the area, particularly of Budaun district, whereas the southwestern part of Shahjahanpur district (Khera Bajhera, Jalalabad and Kant parganas) only has also largest cropping of this crop. The largest eastern and northeastern parts of Shahjahanpur district have the most dominating crop of rice, of both varieties of transplanted and broadcast. It is indicative of the fact that greater rainfall and better irrigation facilities in the district of Shahjahanpur as compared to Budaun district prove very useful for rice cultivation.

The crop of maize is also an important crop, having the second position among kharif crops in the west-southwest of Budaun district.

1. The broadcast rice, locally known as 'dhan' or satthi' is generally used after husking to prepare bread, being pinkish in colour, while the transplanted variety of rice is itself boiled after husking.
Among non-cereal crops, sugarcane is the second largest of all the kharif crops in the eastern half of Shahjahanpur district and in a part in the middle west of Budaun district. With the exception of western-southwestern part of Shahjahanpur district (parganas Khera Bajhera, Jalalabad and Kant), the whole of the district has 9 to 17 per cent of the total agricultural land under sugarcane, while a small area in the middlewest of Budaun district (Islamnagar and Kot parganas) has 10 to 15 per cent under it. Groundnut is also an important cash crop in Budaun district, particularly the middle and southeastern parts (Ujhani, Usehat, Satasi, Sahaswan and Budaun parganas) have 19, 16, 13, 12 and 11 per cent of the total cultivated land under crop of groundnut respectively. The crop is not significant in the Shahjahanpur district, and occupies less than 1 per cent of the total cultivated land. Groundnut, occupies the medium quality land in contrast to lands occupied by Sugarcane. Groundnut is a major cash crop in the area between Ganga and Ramganga rivers while sugarcane is the major cash crop in between the Ramganga and Gomati rivers and trans-Gomati plain area.

**LAND UTILIZATION IN THE RABI SEASON**

The cold weather season, coinciding with the rabi (crop) season, has little rainfall in the area. Irrigation, therefore, plays an important role in rabi cultivation. Some of the rabi crops are, however, grown without irrigation owing to non-availability of irrigation facilities.
Most of the cultivated area is cropped in the **rabi** season, and there is a smaller proportion of fallow land in the **rabi** season, than in the **kharif** season (Fig. 38 B). The fallow land in the **rabi** season varies from 1 per cent to 11 per cent of the total area under cultivation. About 99 per cent of the cultivated area is cropped in the **rabi** season in the northwest of district Budaun (Bisauli, Islamnagar, Kot and Satesi parganas). The largest area left as fallowing in the **rabi** season is 7 to 9 per cent of the total cultivated land in the western and eastern portions of Budaun district (Rajpura, Salampur and Usehat parganas).

In the district of Shahjahanpur, the whole of northwestern area (Tahsil Tilhar) has 96 to 99 per cent of total cultivated land under crops in the **rabi** season, while in other parts of the district the percentage varies between 89 and 95.

A significant feature of **rabi** crops is the mixed cropping, mostly of wheat-gram, wheat-barley, and barley-wheat-peas. Maximum cropping of wheat-gram mixed is in the north-northeast of Budaun district and the middle and western areas of Shahjahanpur district. This is the second largest **rabi** crop in the southern parganas of Budaun and northeastern parganas of Shahjahanpur district, where the first place is occupied by wheat.

In the western part of the area (Rajpura and Asadpur parganas), peas is the second largest **rabi** crop after wheat.

It is second largest after wheat-gram in the middle-north of the area. This crop serves two purposes: before ripening, much of it is used as fodder; and after ripening its grain is obtained and is usually used as pulses or is milled in certain proportion with wheat and used as a flour.
BASED ON UNPUBLISHED DATA OF CROPS IN THE RABI SEASON, 1962-63, IN EACH OF THE MARGAHAS, OBTAINED FROM THE REVENUE DEPARTMENTS OF BUDAUN AND SHAHJAHANPUR DISTRICTS.
Gram is the second largest rabi crop in only the eastern portion of the area (Khutar pargana). It serves generally three purposes, firstly its tender leaves and small soft branches are picked up to use as a vegetable particularly before the fruiting period of the crop; secondly, its grain is obtained for human use as flour and pulse; and thirdly, its straw is used as fodder.

The other crops of the rabi season are barley, pulses, (lentil mainly), barley mixed with peas and wheat, and potato. The maximum acreage of rabi pulses in Budaun district is found in the northeast part (Salempur pargana) whereas in the Shahjahanpur district the maximum acreage is in the north and northeast, (Tilhar, Nigohi, Pawayan and Khutar). Fig. 38 B. The crop of potatoes is produced mainly as cash crop. Potatoes are largely exported to the towns and cities. The greatest areas of potato production lie in the heart of Budaun district (pargana Budaun, Ujhani and Kot) and the southern and southwestern parts of Shahjahanpur district (parganas Jalalabad and Shahjahanpur).

The other non-cereal rabi crops include the oilseeds, fodder crop and vegetables.

RANKING OF CROPS

The ranking of important crops of the area, through the percentage of total harvested cropland occupied by each crop, has served two purposes: first, it has given a picture of the relative positions of strength among the important crops of the year; and secondly, it has presented an areal distribution of different crops in relation to climatic and edaphic conditions.
The first ranking crops as shown in the first-place map (Fig. 39) are millets and pulses, wheat-gram (mixed) and rice in the area. It will be seen from this map that the whole area extending from north-northwest to about the middle of the eastern half of the area (Shahjahanpur district) is occupied by the crop of millets and pulses (mixed); most of the area of this belt, particularly in the southwest, has sandy or sandy loam soil. Along the Ganga and Ramganga rivers, this is the largest kharif crop of the area. In addition, the district of Budaun, in which the crop is most dominant in the kharif season, has smaller rainfall and larger variability of rainfall than the eastern portion. The area under this first-ranking crop varies from 26 to 43 per cent of the total harvested cropland, and is higher in the northeast. In the north of this belt, the mixed crops of wheat and gram occupy the first rank where the soil is mostly loamy or clayey loam, and the rainfall conditions are better in this portion/the southwestern area. The area under wheat-gram with first ranking is 26 to 34 per cent of the total harvested cropland and is higher in the northeast of Budaun district. But in the central and eastern parts of Shahjahanpur district, the crop of rice has the first position of importance among the crops. The predominant soil is loamy or sandy loam but the rainfall in this portion is higher in the area with the least variability of rainfall. The land under rice varies from 20 to 51 per cent of the total harvested cropland and is higher in the canal irrigation zone.

The distributional pattern of crops in the second-rank map is disintegrated as compared to the first-place map. In the second-rank map, the crops of wheat and wheat mixed with gram are most dominant in the area. Where wheat and gram (mixed) occupy the first rank, millets and pulses occupy the second-rank with a percentage of 21 to 33 of the total harvested cropland.
The crop of wheat possesses the second rank in the western and south-western large belt in the area, in the central portions (Katra and Kant parganas) and in the northeastern parts (Pawayan and Khutar parganas). In the western part, the percentage varies from 25 to 33 while in the eastern part it is from 18 to 25 of the total harvested cropland.

The second-rank map shows that the wheat-gram mixed occupies the second position in the middle-north of Budaun district and in the central, western and southwestern parts of Shahjahanpur district, with the exception of two parts, Kant and Katra parganas. The area under wheat-gram varies from 17 to 28 per cent of the total harvested cropland.

A view of the third-rank map shows that the crops occupy more fragmented area than the first and second-rank maps. The third-rank map shows that the western portion of the area has peas as the third ranking crop, while the eastern and southeastern parts have sugarcane. The percentage of peas crop is 13, whereas sugarcane possesses 11 to 18 per cent of the total harvested cropland. Rice is the third ranking crop in the middle of the area. It occupies 14 to 18 per cent of the total harvested cropland. Maize, with a percentage of 8, is the third-ranking crop in the southwest of Budaun district (Sahaswan pargana), while in the northwest of Shahjahanpur district, the mixed crop of millets and pulses occupies 13 to 17 per cent of the total harvested cropland and has third rank. Wheat has a large area as the third ranking crop in the middle-north-northeast of Budaun district and in the southeast of Shahjahanpur district. It possesses 16 to 19 per cent of the cropland.

The third ranking mixed crop of wheat-gram occupies the land southeast of Budaun district and in the north-northeast of Shahjahanpur district. It has 12 to 21 per cent of the total harvested cropland.
The fourth-rank map of crops reveals that rice, sugarcane and peas occupy the largest area as the fourth-ranking crop individually in different parts. The crop of rice, occupying north-northeast and southeast of Budau district, has 7 to 10 per cent of the total harvested cropland. The crop of sugarcane is found in the middle of Budau district and in the eastern parts of Shahjahanpur district, which has a percentage of the occupied land as 11 to 15. The crop of peas occupying the central part of the area as a fourth-ranking crop has an area of 10 to 12 per cent of the total harvested cropland. The western portion of the area is occupied by maize with an area of 11 per cent, while the eastern portion is occupied by gram with an area of 16 per cent of the total harvested cropland. Wheat occupies the western and central parts of Shahjahanpur district with an area of 12 to 14 per cent. The mixed crop of millets and pulses has an area varying from 9 to 14 per cent in the middle parts of Shahjahanpur district, while the mixed crop of wheat-gram occupies the south-southwestern areas in the two districts as the fourth-ranking crop and possesses 7 to 12 per cent of the total harvested cropland.

A comparison of the first and the second-rank map shows that the outstanding crops of the area are mixed crops of millets and pulses, wheat and gram, and the crops of rice and wheat. Millets and pulses are most significant in Budau district and the southwest of Shahjahanpur district which has rice as the third-ranking crop, leaving the second place for wheat-gram mixed; while the district of Shahjahanpur is mostly occupied by rice, wheat and wheat-gram mixed.
A comparison of the third-rank and fourth-rank maps reveals that sugarcane is larger in Shahjahanpur district than in Budaun district, while maize and peas are larger in Budaun than in Shahjahanpur district among low ranking crops of the area. Millets and pulses, which have the largest share in the first and second-rank maps occupying western half and the middle of the area, occupy a small area lying in only Shahjahanpur district among the low ranking crops (third and fourth-rank maps).

Rice occupies mostly first and partly third-rank in Shahjahanpur district. Wheat occupies mostly second and partly third rank in Budaun district. The mixed crop of wheat-gram, one of the major crops of the area, occupies a large proportion of the cultivated land as the first and second-ranking crop in the middle of the area and in the northeast of Budaun district.

DOUBLE CROPPED LAND

The lands which are cropped twice a year have better productive efficiency than those lands which produce one crop in a season, either kharif or rabi, and are left fallow to recuperate the fertility for cropping in the next season or year.

The area under double-cropping is not static, and changes from year to year in accordance with sufficiency or deficiency of manuring and irrigation to the agricultural land. With the increase in the facilities of manuring and irrigation, the percentage of the double cropped area is also increasing. Similarly shortage of manuring, rainfall and irrigation reduces the double-cropped land.
It will be seen from Fig. 40 that the area under double cropping varies from 5 to 25 per cent of the total land under cultivation; and thus the land cropped in one season of the year is at least 75 per cent of the total area available for cultivation. Fig. 40 shows that the western portion (Rajpura, Asadpur), eastern portion (Pawayan), central portion (Salempur) and southeastern parts (Jamaur and Baragaon parganas) have 20—25 per cent of the total cultivated area under double cropping. The western, eastern and middle parts of the area (Kot, Islamnagar, Khutar, Khera Bajhera and Nigehi parganas) have 15—20 per cent of total cultivated area under double cropping. The whole southwest, southeast, middle and the middle north of Budaun district (Sahswan, Usehat, Budaun, Ujhani, Satasi and Bisauli parganas) and most of the western part of Shahjahanpur district (Tilhar, Katra, Jalalpur and Jalalabad parganas) have 10—15 per cent of the total cultivated area under double cropping; while Kant and Shahjahanpur parganas in the southeast of the area have 5—10 per cent of double cropped land.

Actual acreage of double cropped land in each part of the area and its percentage to the total area under cultivation are given in the Table XV. Acreage of the irrigated part of the double cropped area and its percentage to the total double cropped area are also given in it.

It will be seen from this Table that out of the total double-cropped area in each of the parganas (except the smallest pargana of Katra), a high proportion is unirrigated varying from 63 per cent to 100 per cent of the total double cropped area. The small percentage of irrigated land in the eastern part of Shahjahanpur district (Pawayan and Khutar parganas) is mostly due to sufficient annual rainfall in this area which occasionally leads to swampy conditions and such lands are known as 'tarai'; and about 92 per cent of the total land under cultivation is unirrigated.
### TABLE XV

**Double Cropped Land, 1962-63**

<table>
<thead>
<tr>
<th>Pargana</th>
<th>Total area under double cropping (acres)</th>
<th>% of the double cropped area to the total cultivated land</th>
<th>% of Double irrigated area to the total double cropped area</th>
<th>% of unirrigated double-cropped land to the total double-cropped area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>District Budaun</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Majpara</td>
<td>15,854</td>
<td>23.5</td>
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<td>5.6</td>
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<tr>
<td>Asadpur</td>
<td>19,787</td>
<td>21.8</td>
<td>275</td>
<td>1.4</td>
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<td>Sahaswan</td>
<td>18,915</td>
<td>12.4</td>
<td>1,054</td>
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<td>Kot</td>
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<td>10.8</td>
</tr>
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<th></th>
<th></th>
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<tr>
<td>Khera Bajhera</td>
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<td>Tilhar</td>
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<td>Nigehi</td>
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<td>1,864</td>
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<td>Khutar</td>
<td>14,864</td>
<td>19.1</td>
<td>22</td>
<td>0.1</td>
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</table>

**Total** 288,564  19,946  6.9  263,618  93.1
The small percentage of the irrigated area of the double-cropped land in Jalalabad pargana is due to the fact that a large part of its area has a high-water-table, the river Ganga and its tributaries traverse through most of its western-southwestern half, and the Damganga river crosses the pargana in the middle. Thus the soil receives much of its moisture from beneath the surface, and irrigation is mostly not needed.

In double-cropped lands, the unirrigated areas are also of good quality soil. The irrigation is mostly done in the rabi season and the kharif crop irrigated in the double-cropped lands is only rice, particularly when the summer monsoon fails or delays.

The rotation of crops is also a significant feature of double cropping. There are certain rotations but there is no hard and fast rule observed by the cultivators with regard to rotation of crops. The kharif crop of transplanted rice is generally followed in rabi by wheat-gram mixed or only gram. The broadcast rice is rotated with wheat, wheat-peas, wheat-gram-barley, peas-gram or wheat-gram. The crop of maize is usually rotated with wheat in the rabi season. The crop of millets (without continual kharif pulses-'arhar') are followed by barley, peas, barley-peas, lentil or other pulses. The 'chari' crop is followed by wheat, gram or wheat-gram mixed, while the 'jowar' by peas or barley-peas. Occasionally the maize crop is followed by potato or tobacco. If the maize crop is well-manured, it is generally followed by peas in the rabi season. If the jowar crop has been manured in the kharif, or the land is well-ploughed before sowing gram in rabi, the results are good for gram crop. Ample manuring is needed in sowing wheat after maize. The irrigated fields of rice are generally given to peas in the rabi season.

1. The 'chari' is the forage crop obtained from the raw crop of big millet locally known as 'jowar'.
CHAPTER VI
The Selection of Villages

One of the important problems about land use studies in India is related to the technique which should be adopted under Indian conditions and it should be worthwhile to consider this problem in the background of the techniques that have been adopted in other countries.

In Britain an attempt was made to make a systematic record of the then existing use of every acre of land by placing the appropriate letter (specified in a schedule) in its relevant place on the British Ordnance Survey map showing field boundaries and other features. Suitable colours were also assigned to different features.

In the U.S.A., the unit area method of land classification developed by the Tennessee Valley Authority recognized distinct areas of limited extent, each differing from its neighbours due to a combination of particular physical features and these combinations were recorded by a 'fractional notation system' which combined the use of numbers with the use of letters. The technique involved long fractions, short fractions and Roman numerals. The numerators of the long fraction referred to the method of land use and its general characteristics, while the denominator indicated the physical characteristics of the area. The tentative boundaries of homogeneous units were determined by examining large scale base maps and air photographs. The size of the unit varied with the type of the region and the scale of the base map.

The Michigan Land Economic Survey collected information relating to soil, slope, vegetation and similar natural features with the purpose of evaluating the relative merits of the lands in respect of agricultural, recreational or other uses.  

The Rural Land Classification Programme of Puerto Rico made an attempt to indicate both land use characteristics according to its agricultural usefulness.  

The Soil Conservation Service of the U.S.A. prepared a number of maps showing detailed land use patterns and also indicating erosion, slope and soil types by index letters and numbers. The present stress of the U.S. Department of Agriculture is on Land Capability Maps in which the land is classified into eight categories of which only four are suitable for cultivation.  

The land use survey conducted by J.L. Buck in China consists of the data collected from 18,786 farms scattered in 168 localities which are part of 154 basins lying in 22 provinces. The survey included the data relating to population, food, standard of living and marketing.  

The land utilization survey conducted in Poland on county basis in 1953 followed the principles of British Survey with more details of utilization of arable land. It is also proposed to publish a detailed map, on a scale 1:50,000 entirely based on field work in selected areas and as realised by the Polish Geographers, the detailed character of the Polish land utilization survey makes it impossible to cover large areas.

But in India, the agricultural conditions are rather different. In India the cadastral maps of villages showing field boundaries on a scale 1: 3960 are available. These maps are not published like the 6 inch British Ordnance maps, but usually a hand-drawn copy is maintained by the village accountant and copies of this map can be obtained on the availability of necessary sanction from the relevant authorities. Further, it would be most difficult, if not impossible, to record on the map the land use of every parcel of land belonging to all the villages of rural India, particularly when mixed cropping is a common practice and the size of farm units is microscopic. Even if these difficulties associated with the survey are overcome, the land use survey maps may be rendered out of date by the time they are completed and reduced to a suitable scale with documentary interpretation, and soon the need may arise to revise and recheck the survey. In view of these realities sampling technique seems to be the best for obtaining factual information in regard to the existing patterns and problems of land use. Such a technique would not lead us to a total/use picture relating to actual distributions in an area but will undoubtedly be helpful in certain respects. It will reveal clearly the land use problems which may be similar in areas having homogeneity in regard to physical and social conditions.

It is, therefore, necessary to undertake a technique of the sample surveying. There are many types of sampling, out of which three are important: (1) the random or probability sampling; (2) systematic sampling, and (3) the purposive sampling. Simple random sampling means that each sample of 'n'

2. ibid. p. 17.
units from a population of 'N' units has an equal chance of being selected and to ensure true randomness, the method of selection must be independent of human judgement and this is generally achieved by the use of random tables.

Cluster sampling deals with selecting a sample of villages, each single selection leading to a cluster of units (or fields). Then within each of the selected clusters one can include all the individual units which it comprises or only a sample of them, a complete enumeration of these clusters is then taken.\(^1\)

In the National Sample Survey, a stratified two-stage sampling design with two independent and interpenetrating network of samples (IPNS) was adopted for land utilization survey. In each stratum villages, selected systematically with equal probability, were the first stage units and clusters of plots, selected systematically with equal probability from each of the selected villages were the second stage sampling units. For yield survey, a stratified 4-stage sample design was adopted. The sample villages, clusters of plots, plots and circular cuts of radius 4-feet were the successive units of sampling. There was integration of sample villages with respect to crop survey and socio-economic enquiries; that is, the land utilization and yield surveys as well as the various socio-economic enquiries conducted in the same set of sample villages instead of in two different sets. The strata were formed within states by grouping contiguous tehsils which were homogeneous with respect to population density, altitude above sea level and food crops so that the strata populations were approximately equal. From each stratum two independent sub-samples of six villages each

\(^1\) ibid., pp. 17-18
were selected systematically with equal probability after arranging the tahsils in a surpentine order. For land utilization survey in a sample village, generally six clusters of ten plots each were selected.¹

In purposive sampling, the samples are selected as representative of the universe --- the total number of units in an area from which the samples are to be drawn ---. Once the general breakdown of the samples is decided on systematic lines, the choice of actual sample units is left to the investigators. Thus it is a method of stratified sampling in which the selection within the strata is non-random. Theoretically it may be less sound than random sampling but with adequate safeguards it can be made highly reliable and the extra cost of random sampling can be avoided. As in each stratum human factors affecting land use may vary in respect of farm management, accessibility and capital investment, the selection of villages on random basis for land use studies may lead to a less representative picture of the area than that obtained from purposive sampling.²

For purposes of this study the Systematic Purposive Cluster Sampling has been adopted. The physical factors affecting land use, i.e., relief, slope, drainage and soil have been carefully studied and on the basis of these factors the area has been subdivided as far as possible into homogeneous strata and from each stratum representative villages which include cluster of fields have been selected.

In selecting these villages care was taken to choose those villages which represented the typical physical conditions of the type of land from which these were selected. Further, care was taken to select at least

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² Shafi , M., op.,cit., p. 18.
one village from each of the parts of one soil type lying in the western and eastern portions of the area; for instance, one village was selected from the sandy loam tract lying in the western portion as well as one from the eastern. Variations of rainfall in the western and eastern portions of one soil-type were also considered and villages were selected to represent such minute variations. For instance, one village has been selected from the western portion of the loamy soil tract which has a lower rainfall and one from the eastern portion of the same type of soil which has a higher rainfall, seasonally as well as annually; besides, another village has also been selected from the same soil group having the rainfall value in between the two.

In short, the fifteen villages selected for a comprehensive survey of agricultural land utilization cover almost every type of relief, drainage, soil, climate, conditions of availability of water, variabilities of soil fertility, types of crop rotations, and the resultant economic conditions.

The writer, thus, made two extensive visits to each of the selected villages in order to assess the nature of agricultural land use in them and to find out the existing deficiency diseases born out of their prevailing dietetics.

The first visit was made in the kharif season, 1962. Maps of the villages showing field boundaries were obtained and areas were noted from the respective Tahsil headquarters. On the outline maps, the writer recorded the actual land use of the season as witnessed by field-to-field observations. The villagers of the villages were asked each of the following questions and the questions regarding their diets.

1. What crops are being raised? (recording the various crops),
2. For what purpose are the crops grown? (i) cash crops, (ii) fodder crops, (iii) crops of foodstuffs, or (iv) green manure crops to raise the fertility of the soils?

3. What typical kinds of soil are found on the farms?

4. What crop-rotations are being followed on various types of soils?

5. What problems or difficulties are encountered in crop-production and soil conservation?

Each of the houses of the village was enquired about the incidence of different ailings and diseases, along with their obvious symptoms when necessary, and thus all the survey regarding morbidity and mortality was completed for the season. The villagers were also interrogated for the information relating to the yield of different crops per bigha or per acre, types of crop-rotation, type and condition of agricultural implements used, methods of agricultural operations, means of irrigation, and general standard of living.

The same survey was operated again in the rabi season, 1962-63. And thus, for a detailed interpretation of existing use of land, the factual distribution of crops, other uses and non-use of lands were mapped out by the writer and their data have been calculated and tabulated accordingly, which have been given in the description of each village.